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Editor:
J. O. S. MACDONALD, B.Sc., A.R.I.C., A.M.I.Chem.E.

Associate Editor:
I. BERKOVITCH, Ph.D., F.R.I.C., A.M.I.Chem.E.

Assistant Editor:
WILLIAM D. CLIFFORD

The front cover photograph shows engineering staff of McKee-Head Wrightson, London, discussing a petroleum project problem.

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Résumés

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EXTRAPOLATION DES INSTALLATIONS CHIMIQUES — PARTIE II

par D. Q. Kern

Après une discussion des possibilités d'analyse statistique, des dessins fondés entièrement ou partiellement sur l'emploi des facteurs de multiplication, et de l'analyse statistique et mathematique combinée, l'auteur indique plusieurs procédés pour l'extrapolation des grandeurs. Ceux-ci concernent un échangeur de chaleur à double tube à surfaces raclés, pour lequel on dérive une formule basée sur la présence en serie de l'écoulement naturel et turbulent. Au moyen de quelques essais simples le mécanisme essentiel de l'échange de chaleur peut être déterminé et l'extrapolation des grandeurs est effectuée sans l'emploi d'une installation pilote. Parmi les autres exemples cités par l'auteur le cas est mentionné où l'extrapolation des grandeurs pour un refroidisseur à ailettes s'effectue d'une manière sûre sans experimentation.

B.C.E., 4, 11, 589. U.D.C. No. 66.013 : 658.51.

L'ORGANISATION DU TRAVAIL D'UN GROUPE DE DESSINATEURS

par M. Davidmann

Un système d'organisation est décrit visant la retention des frais du travail d'un groupe de dessinateurs dans des limites permissibles et la réalisation de ce travail dans le delai prescrit. L'auteur analyse les fonctions des parties différentes du groupe et propose des méthodes pour le contrôle périodique et la coordination de leurs contributions individuelles à l'aide des diagrammes et des fiches. Par moyen d'une comparaison avec ceux-ci il est possible, après l'achèvement d'un projet, de contrôler les delais prévus et de les améliorer en vu d'emploi ultérieur.

B.C.E., 4, 11, 594. U.D.C. No. 661.715.3 (428).

L'AGRÉGAT LE PLUS GRAND EN DEHORS DES ETATS-UNIS POUR LA PRODUCTION DES DÉRIVÉS CHIMIQUES DU PETROLE

Avec l'achèvement de la troisieme installation oléfine à Wilton, cet agrégat de l'I.C.I. devient le centre le plus grand pour la production des dérivés chimiques du petrole dans le monde. Quelques procédés employés dans l'installation nouvelle sont decrits ainsi que les caractères principaux de l'installation, ci-inclus l'instrumentation et les mesures de sécurité. L'utilisation très poussee des compresseurs à pistons libres mérite l'attention.

B.C.E., 4, 11, 596. U.D.C. No. 66.064 : 551. 464 : 551.481.

LA DÉMINERALISATION SUR GRANDE ÉCHELLE DE L'EAU DE MER ET D'EAU SAUMÂTRE — PARTIE III

par A. M. Eshaya et B. F. Dodge

Les auteurs discutent les possibilités de rendre plus économique la déminéralisation de l'eau saumâtre par voie d'évaporation par compression de vapeur. En utilisant la condensation par gouttes et la circulation obligatoire de l'eau salée il devrait être possible d'obtenir de telles valeurs du produit de la surface et du coefficient de l'échange de chaleur global que les coûts de la production de l'eau déminéralisée par cette methode comparés aux installation existantes puissent etre reduits de moitie.

B.C.E., 4, 11, 605. U.D.C. No. 681.128 : 539.16.

INSTRUMENTS RADIOACTIFS DE NIVELLEMENT

par I. F. Cameron

Des instruments radioactifs capables de déceler et suivre des niveaux variables de liquides sont décrits. Ces instruments peuvent être appliqués aux liquides tenus sous pression dans des vaisseaux clos. Les details des schémas électroniques nécessaires pour leur emploi sont donnés.

Kurzreferate

B.C.E., 4, 11, 582. U.D.C. No. 66.013.5.

FRAGEN DER GRÖSSENEXTRAPOLATION BEI CHEMISCHEN ANLAGEN — 2. TEIL

von D. Q. Kern

Nach einer Besprechung der Möglichkeiten der statistischen Analyse, der völlig oder teilweise auf der Anwendung von Multiplukationsfaktoren beruhenden Planung und der kombinierten statistischen und mathematischen Analyse erläutert Verfasser verschiedene Verfahren für die aufwärtige Grössenübertragung. Diese betreffen einen Doppelrohrwärmeübertrager mit abgeschabter Rohroberfläche, für welchen eine auf der Anwesenheit von nacheinanderfolgendem Stromlinien- und Turbulenzfluss beruhende Gleichung abgeleitet wird. Mittels einiger einfacher Versuche kann der wesentliche Mechanismus der Warmeübertragung festgestellt und die Grössenübertragung ohne Verwendung einer halbindustriellen Anlage vollzogen werden. Unter den anderen vom Verfasser angegebenen Beispielen wird der Fall der aufwärtigen Grössenübertragung eines Luftrippenkuhlers ohne Experimentierung besprochen.

B.C.E., 4, 11, 589. U.D.C. No. 66.013 : 658.51.

ORGANISATION DER ARBEIT EINER PLANUNGSGRUPPE

von M. Davidmann

Ein Organisationssystem wird beschrieben wodurch die Kosten der Planungsarbeit innerhalb erträglicher Grenzen gehalten und ihre Vollendung innerhalb der vorgeschriebenen Zeit sichergestellt werden kann. Verfasser analysiert die Rollen der verschiedenen Teile der Gruppe und schlägt Methoden der periodischen Überwachung und Koordination ihrer Beiträge zur Planung einer Anlage mit Hilfe von Diagrammen und Aufzeichnungen vor. Durch Vergleich mit den letzteren können nach Vollendung eines Projekts die Zeitanschläge für den zukünftigen Gebrauch kontrolliert und verbessert werden.

B.C.E., 4, 11, 594. U.D.C. No. 661.715.3 (428).

DAS GRÖSSTE ERDÖLCHEMISCHE AGGREGAT AUSSERHALB DER VEREINIGTEN STAATEN

Mit der Vollendung der 3. Olefinanlage in Wilton ist dieses Aggregat von I.C.I.-Anlagen zum grössten Zentrum der erdölchemischen Herstellung in der Welt geworden. Einige in den neuen Anlagen angewandte Verfahren sowie die hervorragenden Merkmale der Anlage, einschliesslich der Instrumentierung under der Sicherheitsmassnahmen, werden besprochen. Bemerkenswert ist die weitgehende Verwendung von Freikolbenvorverdichtern.

B.C.E., 4, 11, 596. U.D.C. No. 66.064 : 551. 464 : 551.481

GROSSANGELEGTE ENTMINERALISIERUNG VON SEE- UND BRACKWASSER — 3. TEIL

von A. M. Eshaya und B. F. Dodge

Die Verfasser betrachten die Weisen, auf welche die Entmineralisierung von Salzwasser mittels Verdampfung durch Brüdenkompression wirtschaftlicher gestaltet werden kann. Durch die Anwendung von tropfenweiser Kondensation auf den Heizoberflächen des Verdampfers und durch Zwangsumlauf des Salzwassers könnte es evtl. möglich sein, solche Werte des Produktes von Oberfläche und Gesamtwärmeübergabezahl zu erreichen, dass die Kost der Herstellung von entmineralisiertem Wasser mittels dieser Methode im Vergleich mit existierenden Entsalzungsanlagen auf das zweifache vermindert wäre.

B.C.E., 4, 11, 605. U.D.C. No. 681.128 : 539.16.

RADIOAKTIVE NIVELLIERINSTRUMENTE

von I. F. Cameron

Radioaktive Instrumente für die Anzeigung und Verfolgung von veränderlichen Flüssigkeitsständen werden beschrieben. Diese Instrumente können fur innerhalb geschlossener Behälter unter Druck gehaltene Flüssigkeiten verwendet werden. Einzelheiten der für ihre Verwendung benötigten elektronischer Schemen werden angeführt.

Резюме

B.C.E., 4, 11, 582. U.D.C. No. 66.013.5.

ПРОБЛЕМЫ ХИМИЧЕСКИХ УСТАНОВОК ПРИ ПЕРЕХОДЕ ОТ ОДНОГО АГРЕГАТА К ДРУГОМУ БОЛЬШЕГО РАЗМЕРА — ЧАСТЬ 2

Д. К. Керн

После обсуждения возможностей статистического анализа, конструкций основанных всецело или частично на применении множителей, а также комбинированного статистического и математического анализа, автор описывает несколько процессов для перехода на установки большего размера. Эти процессы относятся к теплообменнику с двойными концентрическими трубками с соскобленной поверхностью, для которого разработано уравнение на основе последовательного наличия ламинарного и турбулентного течения. Путем нескольких простых опытов возможно установить существенный механизм теплопередачи и осуществить переход на установку большего размера без применения полупромышленной установки. Среди других примеров, приведенных автором, упоминается случай, когда охладитель воздушно-ребристого типа может быть достоверно переведен на больший размер без экспериментации.

B.C.E., 4, 11, 589. U.D.C. No. 66.013 : 658.51.

ПЛАНИРОВКА РАБОТЫ КОНСТРУКТОРСКОЙ ГРУППЫ

М. Дэвидмэн

Описывается система организации с целью ограничения стоимости конструкторской работы в допустимых пределах и обеспечения ее заключения в требуемое время. Автор проводит анализ роли различных частей конструкторской группы и предлагает способы периодического регулирования и согласования их вкладов в конструкцию установки с помощью таблиц и записей. Путем сравнения с последними, предвиденные графики могут быть контролированы и улучшены для последующего применения после завершения проекта.

B.C.E., 4, 11, 594. U.D.C. No. 661.715.3 (428).

КРУПНЕЙШИЙ НЕФТЕХИМИЧЕСКИЙ АГРЕГАТ ВНЕ С.Ш.А.

С завершением третьей олефиновой установки в Уилтоне, эта группа установок фирмы I.C.I. стала крупнейшим центром производства химических продуктов на базе нефтяного сырья в мире. Описываются некоторые процессы, примененные в новой установке, а также ее выдающиеся особенности, включая комплектование и меры безопасности. Широкое применение свободнопоршневых компрессоров заслуживает внимания.

B.C.E., 4, 11, 596. U.D.C. No. 66.064 : 551. 464 : 551.481.

КРУПНОМАСШТАБНАЯ ДЕМИНЕРАЛИЗАЦИЯ МОРСКИХ И СОЛОНОВАТЫХ ВОД — ЧАСТЬ 3

А. М. Эшая и Б. Ф. Додж

Авторы рассматривают вопрос о большей экономичности деминерализации солоноватой воды путем испарения из компрессионной холодильной машины. Путем применения конденсации по каплям на поверхностях нагрева испарителя и принудительной циркуляции рассола дана возможность получения таких величин производных поверхностной площади и общего коэффициента теплопередачи, что стоимость производства деминерализованной воды по сравнению с существующими обессоливающими установками может снизиться вдвое.

B.C.E., 4, 11, 605. U.D.C. No. 681.128 : 539.16.

РАДИОАКТИВНЫЕ ПРИБОРЫ ДЛЯ ИЗМЕРЕНИЯ УРОВНЕЙ

Дж. Ф. Камерон

Описываются радиоактивные приборы для обнаружения и прослеживания изменяющихся жидкостных уровней. Такие приборы применимы для жидкостей, содержащихся под давлением в закрытых сосудах. Приведены подробности электронных схем, необходимых для их употребления.

DIGEST OF INDUSTRIAL AND TECHNICAL DEVELOPMENTS

Profit by Clean Air

TO celebrate 60 years of campaigning—under one title or another—for an end to smoke production, the National Society for Clean Air has organised a Diamond Jubilee Conference and Exhibition. Quoted early in its handbook to these events is a message to the inaugural meeting by SIR JOHN BRUNNER: "My experience as a manufacturer proves to me that the evolution of black smoke can be stopped with profit, simply by taking care to burn the coal scientifically. For the rest, I congratulate you on having initiated this movement. . . ." Sessions at the present conference are being devoted to national air pollution problems in several countries, methods of measuring the pollution and technical means of dealing with it. Papers intended to help stop pollution at source are those on gas in industry and on development of solid smokeless fuels. But these are supplemented by a large number on dust removal and suppression from various types of process and on eliminating acidic smuts. In the research section a paper from the U.S.A. describes the use of transparent scale models in the design of dust collector and gas duct systems for coal-burning electric generating stations.

Perspective is given by DR. G. H. DANIEL of the Ministry of Power who refers to the fact that population growth and industrial expansion are increasing world energy requirements at over 5% per year. The growth in fuel consumption is accompanied by a slow but significant deterioration of the fuel mined, including—for both coal and crude petroleum—a rising sulphur content. However, the incentive to remove sulphur from fuel is increasing and is linked with increasing sulphur needs. A well-rounded conference is being completed with several reviews on the role of education in combating pollution and on the legislative and administrative problems of enforcing good practice.

Scientific Foundations

WHAT are the factors essential to the creation of an educated technologist? Does the technologist really operate in a fundamentally different way from the scientist? In a recent article* PROFESSOR H. LEVY has carefully examined these two questions which must lie at the root of decisions on technological education. His first suggestion is to give historical perspective, for example by contrasting the mental and physical environment in which youth grows up to-day, with that of classical times and the social periods that succeeded them. Furthermore, no institution that sets out to provide a modern technological education dare omit from its curriculum a study of the human repercussions of the activities of the technologist. Turning to the more direct question of what the technologist does, the author considers the similarities and contrasts between the approach of the scientist and that of the technologist. The scientist sets himself the task of arranging the elements of, and the relations between his abstractions in a logical way, and deduces certain consequences. But the technologist also has to isolate, from the inter-related medley of entities, those features that seem to him significant for his purpose and to suppress the insignificant. The vital difference is that the scientist usually works in a laboratory under conditions that he can almost control. The technologist is not, in general, so fortunate. Nevertheless, since learning emerges essentially always from experience, what the technologist does is also an experiment. Every completed task is itself part of a technological process of development, and conclusions have to be drawn that are of importance for the next full-scale venture. There must in fact be a methodology of technology just as there is a methodology of science. PROFESSOR LEVY considers it important that the samenesses and the differences of the two processes should be underlined for those who are to be educated to an understanding of the meaning of their work. The remaining two essentials recommended are an understanding of Dimensional Theory and development of power of self-expression.

*_Scientific World III_, 3 (No. 7) 1959 p.3.

Choosing Materials for Fertiliser Plants

PHOSPHORIC acid solutions are corrosive to most of the common materials, the rate of corrosion increasing in most cases with the acid concentration, the temperature and the impurities. Furthermore, plants producing phosphoric acid by the wet process have also to contend with sulphuric acid, fluosilicic acid and fluorine gases, by themselves or in combination with phosphoric acid. Finally, there are a number of cases in which conditions are only mildly corrosive, where common materials may be satisfactory for short periods of operation or for limited use, but would not withstand continuous service over long periods of time. Engineers responsible for choosing the materials of construction for these plants are likely to find useful a detailed brochure on this subject published by the Chemical Construction Corporation of U.S.A. It provides a survey in which materials to be handled are classified into phosphoric acid solutions, phosphoric acid slurries, sulphuric acid, exhaust gases, wastes, superphosphates and superphosphate slurries, ammonium phosphates and phosphate rock. Constructional materials are then dealt with under the headings ferrous metals and alloys, non-ferrous metals, elastomers, plastics and miscellaneous materials. The last classification includes many of the common materials such as concrete, brick or wood, as well as some of the special ones such as carbon or glass.

An alphabetical list of all material surveyed follows, with some data on their chemical resistance to pure and crude phosphoric acid, as a function of concentration and temperature. Both concentration and temperature classifications, however, are intended to cover a range rather than indicate a specific value. Substantial variations can

be found for different materials within the same range. Furthermore, mechanical properties may be poor even if chemical resistance is good. A few typical applications of materials are listed.

The usual cautious disclaimers are naturally added. It is pointed out that a material which has worked very well in one case has sometimes failed quickly in another plant under apparently similar conditions. Nevertheless engineers will be indebted to a compilation which should prove of help to designers and operators in avoiding expensive mistakes.

Developing a Theory for Continuous Dissolvers

IS it possible to develop a general theory for dissolution processes so that laboratory data can be applied in general relationships to predict dissolver performance? So far a considerable amount of effort has been directed toward discovering empirical relationships. The information derived for solution rates as functions of solvent feed rates, fuel element geometry and other variables has been limited to narrow ranges of operating conditions and to the specific metal and solvent systems involved. An attempt has now been made by E. E. ERICKSON of the Phillips Petroleum Co. (U.S.A.) to develop an earlier theoretical approach by SCHNEIDER in which relationships were derived for a continuous rod and a cylindrical slug dissolver and compared with empirical relationships developed in the pilot plant. Before attempting to derive relationships for dissolver performance MR. ERICKSON decided to establish a model for the operation. The model chosen was based on three assumptions:

(1) the reaction rate controls the rate of solution and this rate may be expressed as a simple rate law;

(2) the physical flow of the two phases is continuous and countercurrent, with non-mixing or "tube-flow" of the liquid phase and

(3) the metal behaves as a packed bed of uniform mass of metal per unit column height.

General relationships were then derived on the basis of a first-order and a parabolic rate law, but it was acknowledged that other rate laws could be used as readily. Although the background to the programme was the need to deal with processing of spent reaction fuel elements the solution of aluminium in nitric acid served as an example in the development.

A general equation was written for dissolver performance for each of the rate laws. The two cases, derived for each of three ideal shapes of elements, gave equations (written in terms of dimensionless parameters) of the same form. The final relationships involved the reaction velocity constant, a packing factor, a shape factor for the metal elements, the solvent flow rate, a gas evolution factor, the principal dimension of the initial metal element, the column dimensions and a function of the concentration. The only difference in the equations for the two rate laws appeared in the latter term. This term involved the solvent and metal concentrations in the liquid phase and the reaction stoichiometry.

Report IDO-14450. Office of Technical Services, U.S. Department of Commerce, Washington 25, D.C. Price $1.00.

Further Check on Absorption Theory

RESULTS obtained by V. MIKA at the Prague Institute of Chemical Technology are claimed to show the limitations of the disc column as a basis for measuring rate constants usable in scale-up to full size plant. The HIGBIE concept of the course of absorption was taken as the theoretical model and employed in the calculations. It may be recalled that this assumes part of the surface of the liquid to be exchanged by convection; turbulent eddies continuously bring macroscopic elements of fresh liquid from the interior to the surface where for a certain time they are in contact with the gas and then are exchanged for further elements. Each element of the surface is exchanged when it reaches a certain common "age" and this contact time depends on the hydrodynamic conditions in the system. It is further assumed that on the boundary between the liquid and vapour phase, equilibrium is instantaneously attained and the rate of absorption corresponds to unsteady state absorption into a stagnant liquid of infinite depth. With his disc column, DR. MIKA derived a relation for the rate of physical absorption based on this model of the way absorption occurs with laminar flow of liquid over the discs. He then compared the experimental data for several temperatures with the theoretical dependence of the rate of absorption on the liquid flow rate. The calculated values proved to be lower than the actual ones due to the turbulence in the liquid flowing over the discs.

"Collection of Czechoslovak Chemical Communications." 1959, Vol. 24, No. 9, p.2843.

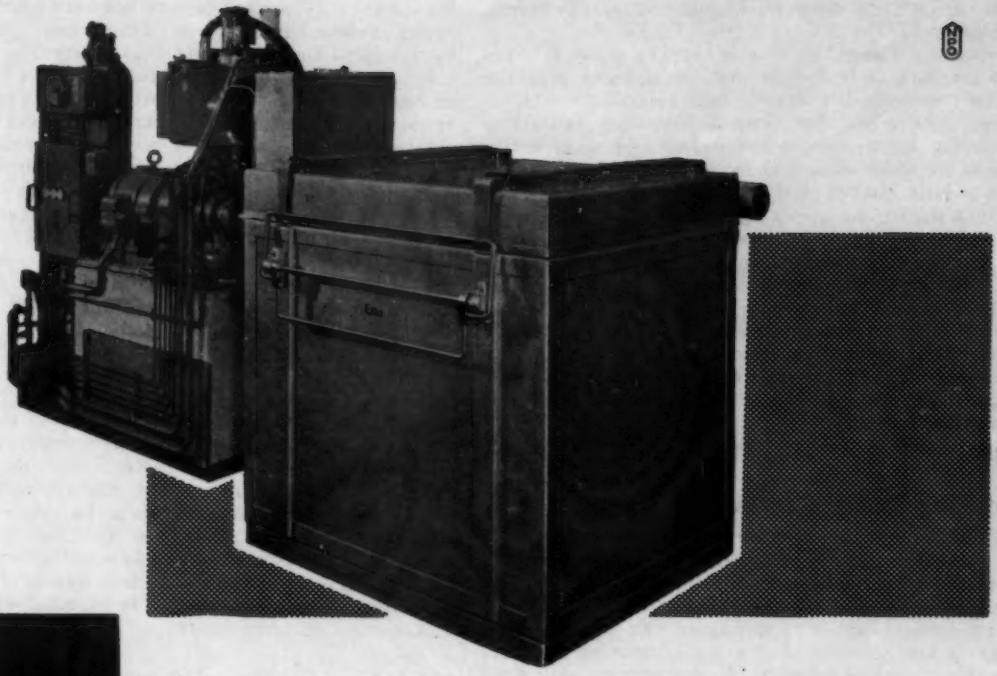
Charts for Quickly Calculating Units of Refrigeration

WHEN designing the volumes of compressors or suction pipes for a new refrigeration plant, the volume taken up by the fluid in the dry saturated vapour state and as superheated vapour must be known. Since this volume depends on the units of refrigeration required, the latter are computed from the Mollier diagrams. However, this procedure may be neither very quick nor accurate as graphical interpolations may be necessary and in fact it is often preferable to make use of tables. This suggested to U. SELLERIO that considerable benefit could be derived from using a series of charts in which the evaporation temperature of the fluid employed was taken as the ordinate, the abscissa giving the number f of units of refrigeration produced for each cubic metre of dry saturated vapour aspirated by the compressor; for convenience the reciprocal of this number was adopted. Three factors are available to calculate these units of refrigeration: the temperature t_u of the fluid upstream of the expansion valve, the evaporation temperature t_o and the temperature of superheating, if any, t_o^1 at which the fluid is aspirated by the compressor. These diagrams have been reproduced on a small scale in *European Technical Digests* for September, 1959 (page 43) with a worked example. The original paper is in *Il Freddo*, Vol. 13, No. 2, 1959, page 1. A considerable number of these charts are available already plotted for the most widely used refrigerating fluids currently employed in industry.

Making Light Work of Heavy Water

THE U.S. Atomic Energy Commission is making available to the public 120 documents on the dual-temperature hydrogen sulphide exchange process for the production of D_2O. The story of this programme appears to start from a report entitled—with appropriate mystery for the year 1943—"Plant Design for the M Process" but continues with more explicit titles referring to work on basic theory and practical design. Included in the documents now available is a new technical report by the E. I. duPont de Nemours & Co. staff, "DP-400—Production of Heavy Water, Savannah River and Dana Plants," a summary of the technology used in the Commission's production units which was completed only last July. The complete list appears in a note No. IN—14 issued by the

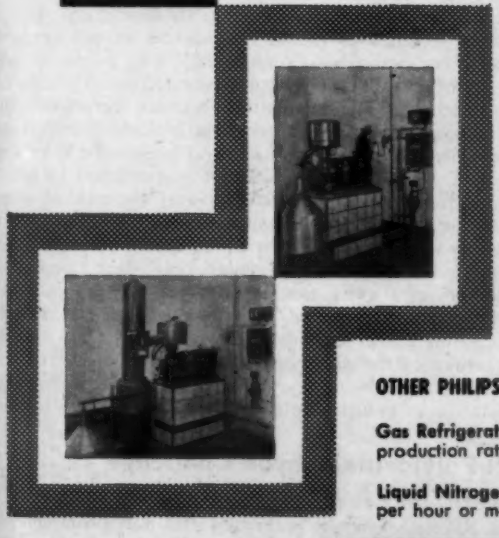
BCE 6335 for further information



PHILIPS

380 LITRES COLD BOX INSTALLATION

for temperatures down to −160° C



- ★ For low temperature treatment of materials, preservation of biological specimens, environmental testing and low temperature chemistry.
- ★ Refrigerating capacity at −100° C 1100 kcal/hr (4400 BTU/hr) and at −160° C 600 kcal/hr (2400 BTU/hr).
- ★ Refrigerating machine also suitable for direct production of liquid air.
- ★ Temperature controlling (to a pre-determined programme) and temperature recording facilities available.
- ★ Refrigerating machine of simple construction; reaches the range of temperatures in a single stage with a compression ratio of 1 : 2.

OTHER PHILIPS CRYOGENIC EQUIPMENT:

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Commission and the documents are obtainable from the Office of Technical Services, Department of Commerce, Washington 25, D.C.

Another dual-temperature cycle based on a high pressure exchange between hydrogen and an aqueous platinum catalyst suspension has recently been reviewed* by M. G. HAWSE. Although this process has very favourable economic characteristics, it suffers from the disadvantage of using hydrogen as feed material and therefore depends on large-scale sources of this gas. A modification which does not require the use of hydrogen as feed material is obtained by causing the hydrogen to flow in a closed circuit and incorporating an extra exchange column in this circuit. This auxiliary column contains a catalyst such as platinum on aluminium silicate or porcelain. Water having normal deuterium content is passed through the column from the top downwards, enriches the circulating hydrogen and is removed as an impoverished product. The enriched material is drawn off between the two dual-temperature columns.

**Platinum Metals Review* 1959 Vol. 3 No. 4 p.118.

Reducing Pump Corrosion

OF the pumps used in the chemical and allied industries, about 90% are centrifugal and diaphragm types. The latter have certain advantages for dealing with severe conditions of chemical attack and abrasion. There is no shaft sealing problem, solids in suspension can be handled at relatively low velocities and a high degree of corrosion resistance can be obtained by the use of high alloy steels for the pump body and synthetic materials for diaphragms. Packingless pumps also include the so-called canned-motor centrifugal pump (see *British Chemical Engineering*, 1957, Vol. 2 No. 11 p.583). JACK E. PICCARDO has reviewed* advances in design and materials for all these types of pumps, intended to improve their service life. Features include improved sealing devices where the pump shaft passes through the casing, new alloys or metals for the wetted end to provide a better corrosion resistance, improved elastomers, plastics and ceramics which permit lining entire pumps for a high degree of corrosion resistance. MR. PICCARDO points out that the centrifugal pump shaft sealing problem can be minimized by the use of a reversed suction design in combination with double mechanical seals. This construction lends itself to applications where both corrosion and abrasion are a factor. Furthermore, improved packing gland and mechanical seal constructions have been developed which isolate the corrosive liquids from the pump shaft and reduce or eliminate shaft leakage in centrifugal pumps. The required corrosion resistance can be provided by the proper choice of materials for the stuffing box or seal parts.

In addition, a bibliography of publications on pumps for corrosive liquors has been compiled by E. MCCOY of the Research and Development Department at Capenhurst (U.K.A.E.A.). It is coded I.G. Information Series 72 (RD/CA) and is obtainable from H.M. Stationery Office for 1s. 9d. References are given to papers, unclassified reports and patents from, *Engineering Index* 1950-57, *Chemical Abstracts* 1937-56 and *Nuclear Science Abstracts* 1948-58.

**Corrosion*, 1959, Vol. 15, No. 9, p.41.

More About Fuel Cells

IN our last issue we referred briefly to the work of F. T. BACON on the hydrogen-oxygen fuel cells which has reached the stage of justifying a demonstration of its use and the release of data on the cell characteristics. Since then we have received a copy of the booklet published by the American Chemical Society containing some of the papers presented in the symposium on fuel cells arranged by their Division of Gas and Fuel Chemistry. This contains titles of four papers and full texts of a further five on various aspects of the subject as well as material on applications of coal acids. There is a report by BACON discussing the performance of his cells in great detail and giving a graph—among many others—of the relationship between weight and hours of endurance for a 44 kW cell of various designs; they range from a lightweight lead/acid traction battery to a fuel cell with cryogenic gas storage.

Separately bound is the account of work on carbonaceous fuel cells by H. H. CHAMBERS and A. D. S. TANTRAM of Sondes Place Research Institute. In their laboratories high temperature fuel cells have been developed which operate at high efficiency on air and a variety of conventional gaseous and vaporised liquid fuels at atmospheric pressure and temperatures in the range of 550°C to 700°C. Inert porous diffusion electrodes are used with molten carbonate electrolytes and the cells are designed for convenient stacking into compact batteries. On the basis of experimental data and a simple theoretical treatment, they have shown that high fuel utilisation at high efficiency is possible in a multi-stage battery. Outputs of at least 1 kW per cu. ft of active volume at an energy conversion efficiency of 78% can be expected, with promise of considerable improvement.

Weighing Solids at 30 mph

ACCURACY of ± 1% of gross weight is claimed for a gamma ray device developed to weigh solids in moving rail trucks. Work has been carried out jointly by Tracerlab, Inc. and a railway company, the New York Central System. In the laboratory an experimental apparatus has been constructed then field tested under railway operating conditions. The scale in its final form would consist of a series of radioactive sources placed perpendicular to and beneath the running rails with a corresponding series of scintillation detectors mounted on an overhead track structure. The attenuation between corresponding pairs of sources and detectors would indicate the mass of a longitudinal segment of the car and integration over the car length could produce an output proportional to gross weight. By proper choice of energy level, the mass absorption coefficient of varying materials may be made nearly proportional to their masses with the result that cars may be weighed without knowledge of their contents. Feasibility tests using the experimental system indicate that the accuracies quoted above are obtained at speeds up to 30 mph with the prototype device. If these results were confirmed the gauge—at present being considered for coal cars—might be used extensively to measure the flow of materials in industrial plant.

Will Polyformaldehyde Challenge Polyethylene?

IN a Russian review it is claimed that polyformaldehyde is greatly superior to polyethylene for impermeability to vapours of gasoline and of hydrocarbons in general. It is also resistant to vapours of alcohol, ethers, esters and solvents containing chlorine, which makes it a promising material for the production of films to be used in packaging. A comparison of polyformaldehyde with other synthetic plastics suggests that it has the closest resemblance to polyamide resins. MR. O. KORSUNSKII, Chief Specialist, State Scientific Technical Committee at the

U.S.S.R. Council of Ministers considers that high-quality synthetic textile fibres can be produced from polyformaldehyde, which is cheap and likely to become cheaper since work is actively in progress to produce formaldehyde by the direct catalytic oxidation of methane in natural gas. The use of natural gas, rather than methane, as the initial raw material for the production of formaldehyde will make it possible to lower the cost of formaldehyde by a factor of no less than 1.5. Technical assets of this thermoplastic polymer include retention of good operational characteristics at elevated temperatures, a high limit of fatigue strength, a low residual deformation and a low coefficient of moisture absorption. Creep strength at low temperatures is somewhat inferior to that for amorphous polymers (polystyrene and polymethylmethacrylate) but superior to that for the crystalline polymers, polyethylene and polyamides. Polyformaldehyde has a slippery surface; the coefficient of friction, 0.1-0.3, is very low in comparison with that of steel. The static and dynamic coefficients of friction coincide and do not change with the temperature. This makes the material particularly well suited for the production of self-lubricating bearings and moving parts of machines. High stability to the action of water, makes it a good material for water line and water conduit fittings.

As distinguished from other thermoplastic resins, polyformaldehyde has a high resistance to the action of organic solvents: it is not soluble in any of the common solvents up to a temperature of 70°C. The polymer is unstable only towards the action of strong acids and alkalies.

Promyshlenno-Ekonomicheskaya Gazeta, 1959, Vol. 4, No. 59 (514) p.4.

Chemicals in Canada—Investment, Production Consumption

STATISTICS about the Dominion's chemical industry have been published as a pamphlet by the journal *Chemistry in Canada*. Supplementing the direct figures is a commentary on many of the industry groups. It can be seen that production of sulphuric acid grew particularly fast from 1956 when the uranium smelters entered production using an acid leach process. In the three year period 1956-58, production gained by almost 50%. However other uses of the acid showed no increase or even declined. Now that the uranium market has levelled off, consumption in 1959 seems likely to be the same as in 1958. Despite this, production of elemental sulphur from natural gas continues its meteoric rise. Production estimates for 1959 suggest about 260,000 long tons—more than double the 1957 tonnage. Major consumers continue to be pulp and paper and the manufacture of sulphuric acid. The element in fact now needs to find itself new uses. (We may note, in parenthesis, that this is the theme of a heart-searching article in *Sulphur* No. 25, July, 1959.)

For chlorine and caustic soda, production increased by better than 12% yearly until 1956, then slowed to around 6-8%. Synthetic rubber and synthetic detergents are both expanding but the fertiliser industry figures shows output static or even declining, with over-production the rule. Primary plastics continue to be one of the fastest growing groups, with sales in 1958 reaching new records. In 1959, estimates by The Society of The Plastics Industry (Canada) Inc. predict large increases ranging from 25% to 60% in production of polyethylene, polyvinyl acetate, polyesters and epoxy resins. Smaller increases will occur in polyvinyl chloride, nylon, phenolic, melamine, and urea plastics. Polystyrene, cellulose acetate, and alkyd resin sales are expected to be about the same in 1959 as in 1958.

An attempt has also been made to present figures for the petrochemical industry although there is, as yet, no "official" definition of it for statistical purposes. Nevertheless, the compilers have accepted as a guide that a petrochemical is "a compound or element derived mainly from petroleum or natural gas or their derived hydrocarbons and having application in chemical processing." Figures based on this definition are presented—albeit with some reserve—but not directly compared with the overall figures for the chemical industries.

Physico-Chemical Data on Antibiotics

ANTIBIOTIC activity has been reported for over 5000 microbial culture filtrates and crude substances, but apparently chemical, physical and biological data are available only for about 735 antibiotics. As an aid in the identification and study of antibiotics A. NEELAMEGHAN and the research staff of Hindustan Antibiotics Ltd. have compiled tables classifying such compounds by physical, chemical and biological data. Summaries of these are due to be published in a series of papers, of which the first has now appeared in *Hindustan Antibiotics Bulletin* 1959, Vol. 2, No. 1, p. 13. It deals with antibiotics produced by bacteria, fungi and moulds, and lichen. Of the 430 antibiotics produced by these groups of organisms, data have been reported for 232 compounds. Where information is available the table gives for each antibiotic the empirical formula, producing organism, crystal form and colour, nature, melting point, ultraviolet absorption maxima, optical rotation, antibiotic activity and whether the structural formula is known or not. Data are then classified by melting point ranges and wavelength of ultraviolet absorption spectra maxima. The former extends from 25°C—375°C by 5° steps and the latter from 210 to 550 millimicrons by unit intervals.

Very Low Pressure Air Ejector

A CONTRIBUTION to design information for ejectors used in ventilation work has been published* by W. G. RICHARDS and W. C. OSBORNE for drive pressures up to 3 in. w.g. Results showed that the pressure ratio (static pressure rise across ejector/driving jet velocity pressure) and area ratio (area of jet pipe/area of mixing tube) were numerically equal for ejectors having area ratios of less than 0.2. Ejector efficiency was found to be about 20% for ejectors likely to be used for ventilation. Optimum proportions were determined and compared with those found by other workers for ejectors using air, water or steam and higher jet pressures up to 85 psi. It was noteworthy that in spite of the variation in the range of area ratio and working fluids, these proportions showed remarkable similarity. Optimum throat length was eight times the mixing tube diameter. The range of area ratios investigated was from 1/2.25 to 1/36.

* *J. Inst. Heat and Vent. Eng.* 1959, Vol. 27, p.172.

Rigorous Method for Stage-by-Stage Calculation in Multicomponent Fractional Liquid Extraction

OPENING with a review of the data for correlating and predicting liquid distribution in liquid extraction, EDWARD G. SCHEIBEL has gone on to present* a new rigorous method for stage-by-stage calculations. The careful presentation of the review and the use of newly developed correlations are not capable of summary and we must refer interested readers to the original paper. In it, theoretical development leads on to an application to the

design of a refining unit to separate the aromatics and paraffins in a reformate fraction. DR. SCHEIBEL shows that a very wide boiling fraction could be charged to a unit depending mainly upon extraction to achieve the desired separation as compared to a relatively narrow fraction when extractive distillation is used to separate the aromatics and paraffins. The study indicates that a more economic operation can be obtained by providing a larger number of extraction stages to give the complete separation in the extractor. It thus suggests that greater emphasis be placed on the liquid extraction phase of the Udex process and less on the extractive distillation portion of the process.

**Petroleum Refiner*, 1959, Vol. 38 No. 9, p.227.

Progress Report by I.A.E.A.

BASIC aim of the International Atomic Energy Agency (I.A.E.A.) is to "accelerate and enlarge the contribution of atomic energy to peace, health and prosperity throughout the world." In terms of programmes this is considered under the headings of generating power, applying radiation and ensuring that the development of atomic energy throughout the world does not constitute a hazard to health and safety or a threat to security and peace. The second annual report covering the year up to 30th June, 1959, notes a rapid expansion of activities. The Agency is preparing an International Directory of Radioisotopes and Labelled Compounds, the first volume of which has already been published. This directory will give detailed information on all radioisotopes and labelled compounds which are now commercially available, together with information on their radiation characteristics, the forms in which they are obtainable, their prices and their producers. To keep it up to date, it is intended to revise this document periodically and issue supplements. In addition the Agency's first health and safety guide, a manual of safe practice for the handling of radioisotopes, was issued in December, 1958. An expert panel met in April, 1959, to start work on recommendations on the transport of radioisotopes. Another panel is dealing with the transport of substantial quantities of radioactive materials, such as irradiated fuel elements. Others are working on radioactive waste disposal in the sea and in the soil.

In a general summing up of the Agency's activities during the period under review, the Board of Governors says: "During the past year, the Agency has begun to work in all the fields covered by its Statute. The extent of its activities has, however, varied considerably, the most notable growth being in the field of technical assistance, including fellowships, and health and safety and radiation protection." Details of these activities are available from the Public Information Division, International Atomic Energy Agency, Kärntnerring 11, Wien 1, Austria.

Foams

TO produce a durable foam, what are the conditions to be fulfilled? The liquid must have a low surface tension to minimise the work needed to increase the surface area; this surface tension must be sensitive to small changes in the surface concentration. A flow of insufflated gas must match the speed of migration of active molecules towards the interface. Separation of liquid phase from the foam must not be fast and this implies a high bulk viscosity, low liquid density, low pressure gradient in the direction of junction of three films, and a high interfacial viscosity. Reviewing this complex problem A. MICHILS in *Industrie Chimique Belge*, 1959, Vol. XXIV, No. 8, p. 901, adds that a delay must exist in the re-solution of surface molecules. This hysteresis gives the bubbles increased elasticity which strengthens their resistance to external shock. Other requirements are a poor possibility of escape for the constituents which presumes that there is low permeability to gas and that the solvent has a low vapour pressure. High electro-kinetic potential is also required.

These factors are of unequal importance and may even act in mutual opposition. For example a high bulk viscosity slows down the rate of formation of a foam, but, once it has been formed, contributes to its stability. DR. MICHILS points out that there are many practical questions to be answered in foaming studies and in understanding anti-foam agents. His initial aim however has been to isolate from this complex physical phenomenon the details of the mechanism and to describe the conditions which make it possible.

Teaching Fluidisation by Film

ALTHOUGH intended for schools, Rotary Clubs and similar non-specialist audiences, a film* recently produced for Esso Research and Engineering Co., might also be useful to plant operatives to show them the principles behind both catalysis and fluidisation. With simple demonstrations it discusses the advantages of having solids in a form where much of their behaviour is like that of liquids then shows how to throw them into this form. Most of the film consists of live laboratory demonstrations and shots of plant with a small proportion of animated diagrams. There are enough touches of humour to make for interest in a school-level audience, while the theme is continuously carried forward to show the principle of fluidised catalytic cracking. The effect of the cracking is shown in a sequence with models of molecules. A rather gushing closing sequence on the brighter life for all that the beneficent sponsors are producing, is, we understand, due to be cut from the British version of this American product. A further possible weakness and more difficult to remedy, is the rather hasty treatment of full-scale plant. But despite these features the film ably fulfils its intentions; it is well worth seeing, well worth showing.

* *Report on Research No. 1—Flowing Solids*, 17 *minutes, Sound, Colour, 16 mm.* Available from Esso Petroleum Co., Ltd., on free loan.

Filtering Cement Slurry

A NEW process employing filtration to remove a substantial proportion of the water content from cement slurry before it is dried in the kilns has recently been developed by British Portland Cement Manufacturers Ltd. This is the first time that filtration has been used in cement manufacture in Britain and it is believed to be the first cement manufacturing process in the world to use plate and frame presses although rotary vacuum filters are used in some overseas countries. The filtration system has been developed at the company's Shoreham Works in Sussex where the raw materials used are chalk and clay. After the chalk has been mixed with water and reduced to a fine particle size the clay is added and the mixture is subsequently fed into kilns.

The installation at Shoreham consists of three 48-in., 80-leaf presses operating at a filter pressure of 120 lb./sq. in. Each press is dropped about 17 or 18 times during a period of 24 hours and deposits somewhere around 10 tons of cake at a time so that the capacity of the plant is between 3000 and 4000 tons a week. The filter cloths are of 12½ oz./sq. yd. continuous filament plain weave nylon fabric. Although the intial cost is high, the nylon fabric is reported to have a very long life as a result of its great tensile strength, outstanding abrasion resistance and immunity to rotting.

British Chemical Engineering
A HEYWOOD PUBLICATION

Ventures into Space

NO epoch in history has produced such a succession of stupendous developments as the present, and never nave so many remarkable projects been contemplated. Not the least staggering among them have been in the sphere of space exploration and if it was not already clear from previous projections into space, such as the artificial planets in orbit round the earth and the direct hit upon the moon, the looping of that planet by Lunik 3 must surely have removed all doubts that we have entered the era of space travel and exploration by manned vehicles. What has earned respect and admiration from scientists and technologists with the more recent flights has been the extreme accuracy with which the projectiles have been placed in their orbits. In the case of Lunik 3, the launching speed of 25,000 mph had to be correct to 1 mph for its successful circumnavigation of the moon to be possible. This striking example of closeness of aim and achievement is evidence of man's growing mastery over the heavenly forces and the encirclement of Mars and Venus and the launching of a manned spaceship can now be seen as realisable objectives whose problems will inevitably be solved. There is little doubt that these exciting developments and prospects are welcomed by many scientists and technologists, but it is equally evident that less understanding or less well-informed circles greet them with either indifference or opposition.

It is often argued that, since there are so many pressing problems still to be solved on this planet, space exploration in such circumstances is a needless dissipation of resources. This objection had its counterpart centuries ago at a time when the pioneer explorers were seeking support for their often-unpopular expeditions and voyages. Then it was said that to seek new lands at the remotest corners of the earth with the then-limited means of transport and navigation, and while there was still room for expansion at home, was futile. How mistaken this view proved to be! For though the ventures of the early explorers were regarded as acts of extreme folly, and the leaders of even successful expeditions received but niggardly rewards for their heroism and for the privations they had endured, their discoveries had the profoundest influence upon the development of civilisation.

Unlike the early terrestrial explorations, the space projects of today do not lack support, and in the two countries most concerned with them at present they receive powerful backing from the respective governments. This is because the satellites are a by-product of long-range military rocketry and, apart from an ingrained fear of the unknown, antipathy to the ventures into space springs from fears that the offspring of military machines may themselves have too destructive aims. Indeed, atomic energy itself has earned little public acclaim—the lay Press has not helped with its sycophantic treatment of the subject—for the very reason of its own military origin. Fortunately, the growing realisation of the immense value of atomic energy is forcing its origins into the background. And, again, if the relations between the two major powers in the world become less strained and more cordial, and as mutual respect between countries of differing political systems grows—a situation promised by recent events in the U.S.A. and the Soviet Union—then the emphasis will shift to the immense benefits which can flow from these achievements and, as a consequence, their military genesis will be overshadowed.

What is the case for these journeys into the unknown? First, there is the certainty of acquiring an abundance of valuable scientific knowledge as the results obtained from these early projectiles confirm, and of an immeasurably broader picture of the universe than the limited one we now have. It is, of course, in the nature of things that the secrets which research will wrest from nature cannot be foreseen in advance. Nevertheless, if the history of science proves anything it is that research over wide fields ultimately yields high practical dividends.

A number of branches of applied science are likely to benefit enormously from the knowledge now being accumulated and from the methods and techniques that are being evolved. Meteorology, for example, may well reach the stage where accurate weather forecasting upon a global scale becomes an established practice. The economic benefits that would stem from this would be enormous, and beyond this stage lies the possibility of some measure of control over the weather itself. Thus there is the chance that those troublesome problems of water supply to arid regions of the world may be solved, so to speak, at their source. So, too, would it become possible to make far greater use of solar energy for a variety of purposes. The study of the upper atmosphere and beyond will undoubtedly lead to quicker aerial transport, and the materials and techniques developed for the explorations, particularly the highly precise means of control, cannot fail to be valuable to industry and to society.

Apart from these rather obvious considerations, space exploration will open up fields of knowledge at present undreamt of. And in the more distant future lies the possibility of discovering inhabitants upon other planets, some, perhaps, at a less and others at a more advanced stage of development than ourselves, and the exciting prospect of communicating with them.

On a very much lower plane is the boost that space travel will give to cryogenics, for huge quantities of liquid oxygen, fluorine or hydrogen may be required. In the case of the two latter elements, the problems of tonnage manufacture may provide a fruitful field for chemical engineering.

66.013.5.

SPECULATIVE PILOT DESIGN AND SCALE-UP

PART II*

In the second part of his article the author gives examples of scaling-up with the minimum of experiment.

by Dr. D. Q. KERN

MANY chemical engineering phenomena may be described by first and second order differential equations. When the final relationship governing a phenomenon is concluded by the integration of measured derivatives, it should be noted that *integration is an averaging procedure and the precision of the final statement is fundamentally increased.* Conversely, when derivatives are pieced together analytically from the measured responses of integrals the precision of the statement is reduced in numerous ways due to such factors as sequential measurement and errors inherent in integrals but not necessarily the derivative.

Chemical reactions furnish an excellent area in which it would be highly desirable to measure a rate directly. The differential equation governing the chemical reaction rate is the well-known mass action law which states that the rate of reaction is proportional to the active masses of the reactants. The characteristic experimental constant is this proportionality factor which is the specific reaction rate.

If it were possible to measure the reaction rate directly in addition to the active masses one could obtain the specific reaction rate simply by division. Because of the absence of direct rate measurement procedures it is usually necessary to measure an integral of the differential equation and the law of mass action to obtain the total amount reacted as a function of time. Even worse—many integrals in kinetics have to be measured on the run—so to speak—while they are still changing!

Statistical Analysis and Other Approaches

After exhausting the possibilities of similarity a system may remain unresolved because it is still inundated with variables and responses. In this case one cannot tell what to reject because many responses are affected by a single change in each of many variables. When this occurs the design of the experiment should be changed.

There still remains the enormous relatively untapped potentialities of statistical analysis and factorial or partial factorial designs. These allow the development of a *figure of merit* and multidimensional surfaces having maxima and minima which can be followed in the same sense as a mechanism.

In the author's experience this latter method has proved most effective in the resolution of régimes which are characterised by a large number of components and a large number of tests and responses. Such an approach can even be applied successfully to the formulation of paints, synthetic rubber compounds, printing inks, and innumerable others. It converts formulation to the status of a science.

Also significant is the combination of one or more methods such as empirics and mathematical analysis, empirics and statistical analysis for the resolution of different responses, or the combination of mathematical analysis and statistical analysis. The last appears to be the great void in modern experimental technology, although Fick's Law represents a first approach. Perhaps the digital computer will prove to be the greatest experimetal tool devised so far.

Illustrative Examples

The illustrative examples given here cover single components and are fairly narrow in scope to conserve space. They have provided a substantial reduction in research for scale-up or its total elimination. The industrial counterparts have been designed and constructed many times although actual performances are not documented for proprietary reasons. The important part is that through the postulation of a mechanism all of the design equations were definable by derivation and all of the end applications worked in excellent agreement with the speculation.

Example 1. *Object: Expand Generality of Non-theoretical Equation. Application: Chilling by Means of Scraped Surfaces.*

The scraped surface double-pipe exchanger shown in Fig. 1 is used for the dewaxing of chilled petroleum fractions and for sensible heat transfer to other viscous fluids and semi-solids. The inner pipe is equipped with a rotor having blades which bear against the pipe and displace the fluid at its surface by scraping. Sensible heat transfer through the unit could occur by conduction if laminar flow prevails or by turbulence and convection with some transition between the two. Assuming convection, Skelland[7] obtained an equation through dimensional analysis which he evaluated thus

$$\frac{hD}{k} = 4.9\left(\frac{DV\rho}{\mu}\right)^{0.57}\left(\frac{c_p\mu}{k}\right)^{0.47}\left(\frac{DN}{V}\right)^{0.17}\left(\frac{D}{L}\right)^{0.37} \quad \ldots . (7)$$

* Part 1: October issue, p. 530.

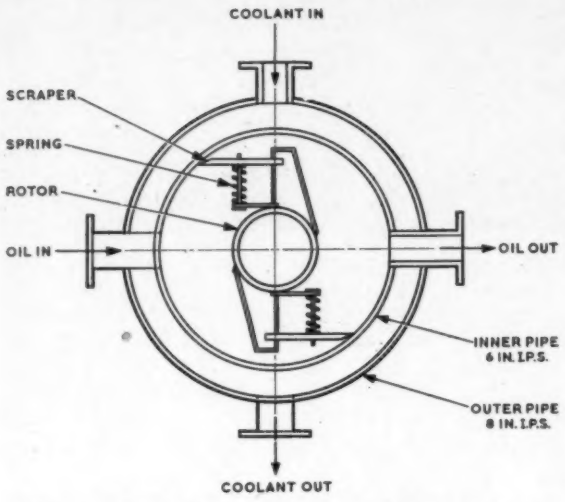

Fig. 1. Schematic view of scraped surface heat exchanger (Courtesy: Richard M. Armstrong Co.)

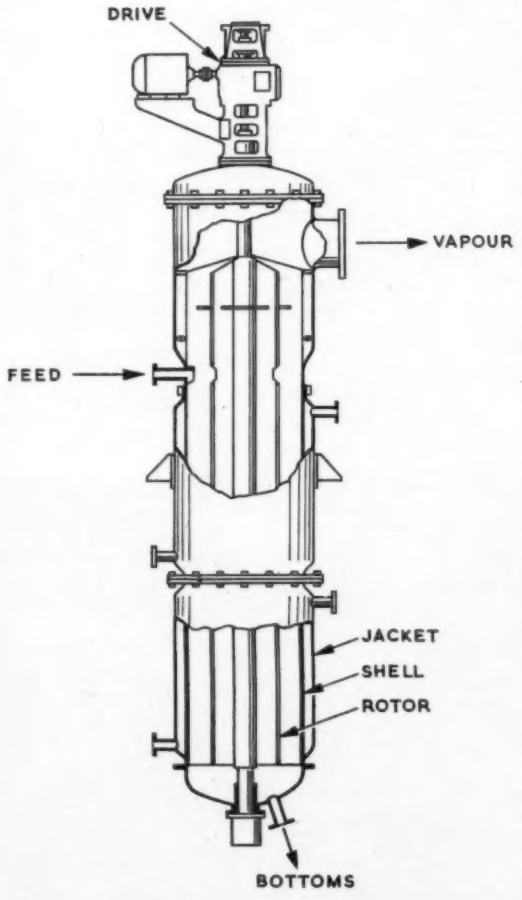

Fig. 2. Annotated diagram of thin film processor (Courtesy: Rodney Hunt Machine Co)

D is the diameter of the inner pipe, N is the rotation in rpm, while V is the axial linear velocity. By employing V in the Reynolds number instead of the product $D \times N$ it was necessary to add the term DN/V to reconcile the axial and rotational velocities. Such a correlation must of necessity have a limited range of applicability and could in fact be misapplied in the presence of pure laminar flow.

Consider now a more general postulation[9] to include streamline and turbulent flow in series. The viscous core of the fluid between scrapers is fundamentally in laminar flow rotationally as well as axially and is represented by a resistance to conduction. The opportunity for turbulence at the leading tip of the scraper is provided by expressing the effect of convection as a thickness of liquid δ such that the convective resistance is defined by δ/k where k is the thermal conductivity. The overall coefficient then contains both resistances. The differential equation for heat conduction is given by Equation (IX) in the Appendix and in cylindrical co-ordinates with axial symmetry it is expressed by

$$\nabla^2 t = \frac{k}{c_p \rho} \frac{1}{r} \frac{\partial}{\partial r} \left(r \frac{\partial t}{\partial r} \right) \qquad \ldots . (8)$$

which, solved, gives

$$\frac{\delta}{k} = \frac{Q}{\pi D L \triangle t_c} = \frac{2k}{\sqrt{\frac{\pi k \theta_s}{c_p \rho}}} \left[1 - \frac{\sqrt{\pi}}{4} \left(\frac{4k\theta_s}{c_p \rho D^2} \right)^{\frac{1}{2}} - \frac{1}{12} \left(\frac{4k\theta_s}{c_p \rho D^2} \right) + \ldots . \right] \qquad \ldots . (9)$$

where θ_s is the time between scrapings, r the radius and $\triangle t_c$ the temperature difference across the conduction resistance. If a few runs indicate that δ is small, positive and nearly constant then the mechanism of laminar flow would be confirmed. If, on the other hand, it shows regular variation with the operating variables the implications of the important contribution of convection are indicated. If it proves erratic then a discontinuity can be identified such as a transition from predominant streamline to predominant turbulent flow. But all possibilities are included.

Example 2. Object: Identification of Mechanism to Develop Probe. Application: Thermal Processing With Agitated Thin Films.

The thin film processor shown in Fig. 2 is used for simultaneous heat and mass transfer involving temperature sensitive fluids. Here a clearance δ is objectively maintained between the rotor blade and the shell. Feed enters below the entrainment separator and descends through gravity. Fig. 3 is a view through the thermal section of the processor.

It has been shown[9] that the descending fluid, as a result of centrifugal force, can only reside at the clearance δ and as a fillet on the lead side of the blade. Since the fluids may be non-Newtonian and since it is also possible to have some phase change the fillet can have any of the appearances shown in Fig. 4 as it descends. The dash lines indicate defective fillets, that is, ones which by virtue of quantity or viscosity do not respond to the rotor and hence represent a discontinuity of mechanism.

Articles and sales literature have suggested that the device operates independently or dependently of temperature difference, surface, viscosity, etc., and hence is not definable by equations. It was recommended that each fluid and process change be run in a laboratory model and then "scaled-up". Since there were no relationships for scale-up such as the influence of an increase in feed on an increase in diameter and/or height, scale-up is really reduced to a guess.

The erratic behaviour of results both in the literature

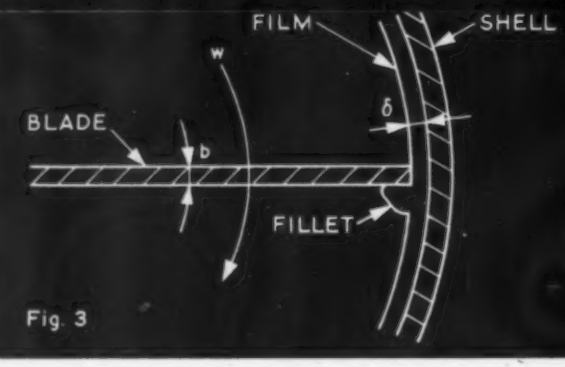

Fig. 3

Fig. 3. View through thermal section.

Fig. 4. Typical fillets.

(a) Decreasing fillet I—normal II—deficient

(b) Increasing fillet I—normal II—deficient

(c) Maximum fillet between L=O L=L

Fig. 5. Typical dirt growth curve.

Fig. 6. Plot of derived equation with arbitrary constants.

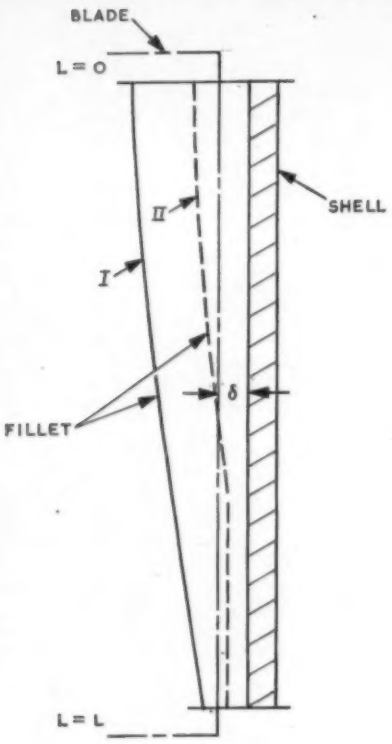

Fig. 4a

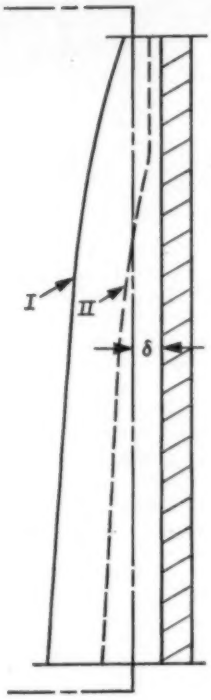

Fig. 4b

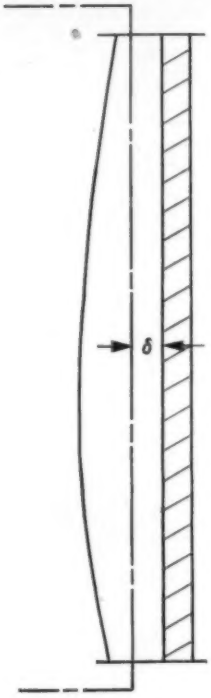

Fig. 4c

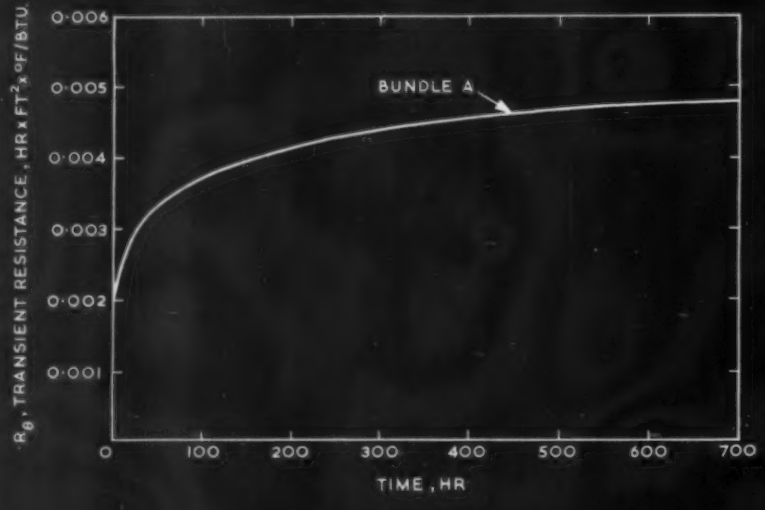

Fig. 5

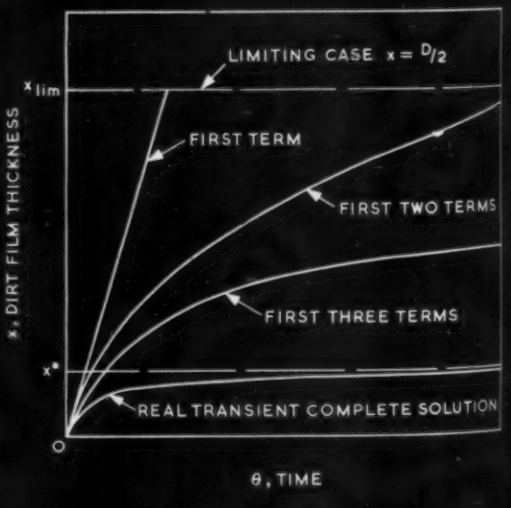

Fig. 6

and on surveying some prototypes which were "scaled-up" from the model suggested the possible disappearance of the fillet in some instances. A viscous fluid in the small clearance between blade and wall will almost invariably be in laminar flow both from rotational and gravitational references.

The fillet is different. It only exists when all of the fluid is unable to descend in the clearance between blade and shell. The object is to assure the presence of a fillet since it produces the principal element of turbulence when the phase change is very small or non-existent. Its presence also assures that veinlike flow will not develop near the bottom of the processor thus invalidating the presence of the heat transfer surface. Solving Eq. (VIa), the Navier-Stokes equations, one obtains for the wall flow velocity

$$\frac{\partial^2 \dot{z}}{\partial r^2} = -\frac{\rho g}{\mu} \qquad \ldots . (10)$$

and for the fillet

$$\frac{\partial^2 \dot{z}}{\partial x^2} + \frac{\partial^2 \dot{z}}{\partial y^2} = -\frac{\rho g}{\mu} \qquad \ldots . (11)$$

where $\dot{z}$ is the vertical velocity component.

To determine whether there is fluid in the fillet for a given feed rate, diameter and clearance, it is necessary to determine the hold up at every point. The fillet must have a cross-section at every point to represent the disposition of the fluid from point-to-point. But its shape is complex and it is subject to an unusual group of forces. Refer again to Fig. 3 and note the possibility that a triangle might serve as an approximation of its shape. Stokes' theorem states that the flow in an open channel having a planar free surface is identical with that in a closed channel whose walls consist of the walls of the channel and their mirror images projected through the free liquid surface. Thus, the volumetric flow rate for a square vertical channel is shown by Boussinesq to be

$$V' = K_1 \frac{\rho g}{\mu} X^2 \qquad \ldots . (12)$$

where K_1 is a constant (0.14) and X the cross-section of the square. According to Stokes the right hand term is then divided by 2. If there are n fillets the holdup H is

$$H = 2\pi RL\delta + nLX \qquad \ldots . (13)$$

where $r = R$ is the radius of the processor and L its length. The cross-section of the fillet is

$$X = 3.8n^{-\frac{1}{2}} \left[\frac{\mu V'}{\rho g} - \frac{2\pi R\delta^3}{3} \right]^{\frac{1}{2}} \qquad \ldots . (14)$$

When the right term in brackets equals or exceeds the left there is no fillet and the fluid undergoes no rotation. Since these are usually viscous heat sensitive fluids which are processed the holdup itself is important.

$$H = \int_0^L (2\pi R\delta + nX)dL = 2\pi R\delta L + 3.8n^{\frac{1}{2}} \int_0^L \left(\frac{\mu V'}{\rho g} - \frac{2}{3}\pi R\delta^3 \right) dz \qquad \ldots . (15)$$

This last can in turn be related to the temperature, composition and change in properties with both. However, heat transfer and diffusion effects can now be restricted to conditions which pass the test of wetting the entire surface or computing the fraction wetted.

Example 3. Object: Development of a Mechanism for Data Already Published. Application: Designing Thermal Surfaces to Run Indefinitely.

It it a fairly simple matter to allow for the accumulation of dirt in a pipe by increasing its diameter. If the surface of the pipe is also used for heat transfer however, it usually takes but a small amount of accumulation to render it unsuitable. Consider the case where the resistance to heat transfer R_θ is proportional to the thickness of the dirt x_θ at time θ. The resistance at a given liquid velocity has been measured[10, 11] as shown in Fig. 5. When the fouling fluid is circulated at greater velocity the height of the curves is suppressed. What is the connection between fluid velocity and fouling resistance?

It is seen[12] in Fig. 5 that the graph aims toward an asymptote R^* such that each curve is related to time by an expression of the form $R_\theta = R^*(1 - e^{-B\theta})$ where B is an arbitrary constant. Little is known of the mechanism of dirt accumulation but this really isn't important. Through methods at present available it is not universally possible to eliminate dirt completely and economically from most streams so that one might as well accept for the present the necessity of accommodating it in thermal design. Fig. 5 tells what it looks like.

If velocity reduces accumulation it is probably because of the shear stress exerted by the fluid at the wall. Assume that accumulation is the net difference between dirt deposition and dirt removal. With little else to go on relative to the deposition of occasional dirt particles on a surface, assume it to be directly proportional to the concentration of dirt c' in a constant weight flow stream, W. Consider dirt removal to be proportional to the shear stress, τ. The growth in dirt thickness with time is then given by

$$\frac{dx_\theta}{d\theta} = K_1 c' W - K_2 \tau x_\theta \qquad \ldots . (16)$$

K_1 and K_2 are constants. Integration of the rate equation for x_θ with τ expressed in terms of x_θ produces a sequence of terms shown graphically in Fig. 6. Fig. 6 closely approximates Fig. 5. But it yields something more. Since the variables are expressed in terms of the fluid velocity it is possible to determine the pressure drop needed to suppress the dirt to a permanently tolerable level. This works out most advantageously so as to encourage the design of thermal plant facilities which require no cleaning —in theory at least, during their operating lifetime. The thickness of the dirt is expressed by

$$x_\theta = \frac{K_1 c'}{K_2} \left[\frac{W^3 L^4 \rho g}{(\triangle P)^4} \right]^{\frac{1}{5}} \qquad \ldots . (17)$$

The values to be measured are thus K_1c'/K_2 which previously were unidentified in published experiments and which were not known prior to assuming a mechanism. By dividing values of x_θ for the same fluid under different operating conditions, even the determination of K_1c'/K_2 can be eliminated. For any other fluid one can guess the starting point, as a ratio of K_1c'/K_2 and let the remainder of the equation furnish the direction of variation.

Example 4. Object: Designing on the Large Scale Directly. Application: Air-fin Cooler Design.

The air-fin cooler is a device for removing high level heat employing atmospheric air and high fin tubes. It is extremely useful whether or not water is available. A forced draft cooler is shown in Fig. 7. The (Wolverine) aluminium high fin tubing is shown in Fig. 8. It has a root diameter of 1.08 in., 2.0 in. OD fins, 9 fins/in., 0.019 in. thick.

Like forced draft cooling towers, the hot discharge air leaves the heat transfer surface at low velocity and not very far from the high velocity air intake. This gives rise to a recirculation of the heated air with the ambient air causing a decrease in the effectiveness of the ambient air temperature. It also increases the power requirement due to the expanded volume of the hotter recirculated air.

Forced draft heat transfer and pressure drop data on

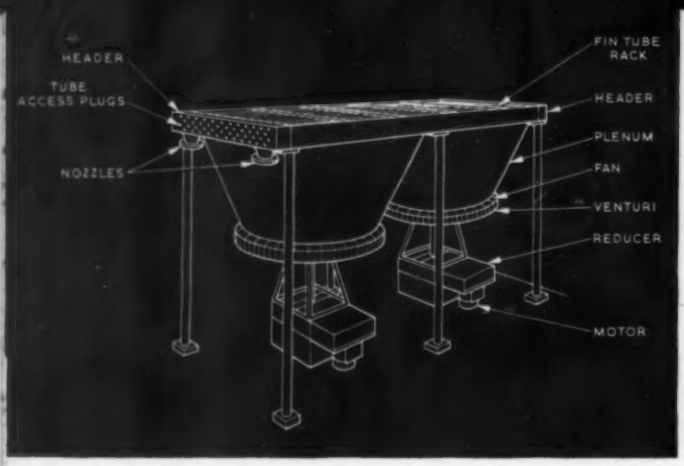

Fig. 7. Annotated line drawing of a forced-draught air-fin cooler.

Fig. 8. Illustration showing Wolverine high and low fin tubes. (Photo: I.C.I. Ltd.)

a commercial scale[13] are shown in the five plotted points on Figs. 9 and 10. The equivalent diameters employed are

$$D_e = \frac{2\,(\text{total surface})}{\pi\,(\text{projected perimeter})} \qquad \ldots.(18)$$

and

$$D_v = \frac{4\,(\text{net free volume})}{\text{total suface}} \qquad \ldots.(19)$$

The remaining nomenclature is common in heat transfer studies. It is desired to establish a heat transfer curve for induced draft air-fin coolers.

It is known that a square foot of air-fin surface in induced draft is less effective than it is in forced draft. The difference decreases with the number of rows normal to air flow and disappears when the bank of tubes is ten rows deep.

The mechanism may be the following: The ambient air in forced draft strikes the heat transfer surface at a high velocity without complete propagation despite the plenum chamber. In induced draft it reaches the surface at a low velocity and is accelerated only after it passes between adjoining tubes. The reduced turbulence on the surface facing the air flow reduces the heat transfer coefficient per square foot of surface for the first row of tubes in spite of the circumferential heat conduction of the fins. After passing through the first row of tubes the air impinges turbulently on the remaining surface which is usually on triangular pitch. The identity of the heat transfer deficiency of the first row is reduced as each row of tubes is added.

The friction factor curve does not show this same effect. The pressure drop is closely proportional to the number of rows. Why? Some minor calculation indicates that the contraction loss on the first row offsets the low approach velocity. A first row thus contributes about as much pressure drop as each additional row but not as much heat transfer.

How then can an induced draft heat transfer curve be constructed without experimentation? Pierson,[14] and Kays and Lo[15] studied heat transfer for air across banks of bare tubes. Their data were given in tabular form as correction factors F_N for the mean value of banks N rows deep versus a bank 10 rows deep. By plotting the ratio of the first differences of $\triangle F_N/\triangle N$ *vs.* N it was possible to establish the remainder of the curve shown in Fig. 10 and to express the relationship quantitatively. Thus the air coefficient for a ten row bank, h_{10}, resulting from the five plotted points is expressed by

$$h_{10} = K_1 V^{0.5} \qquad \ldots.(20)$$

For the remainder of the grid from 2 to 9 rows let the coefficient be h_N. One obtains

$$h_N = K_1 V^{0.5}(1 - 0.5e^{-N/3}) \qquad \ldots.(21)$$

Quite admittedly this represents the use of bare tube data for the computation of a fin tube curve. But what is its reliability? The forced draft curve represents actual, consistent plant scale data on five different units and is admissible. If anything, the fin tube curves will not fan out as much as shown because of the additional friction drag per row which reduces the ratio of the initial contraction loss to the total pressure loss. The presence of in-line fins also reduces the turbulence somewhat.

Since the uppermost curve represents real data the lower curves will all be on the safe side. When one or two air-fin coolers are designed from this curve their conservatism can be evaluated quantitatively and a new graph drawn. Experimentation will have been eliminated and the final answer will have been established by a safe approach on the large scale itself.

ACKNOWLEDGMENT

The author wishes to express his thanks to the sponsors of the projects referred to under "Illustrative Examples". These are: Example 1, Richard M. Armstrong Co., West Chester, Pa.; Example 2, Rodney Hunt Machine Co., Orange, Mass.; and Examples 3 and 4, Wolverine Tube, Division of Calumet & Hecla, Inc., Allen Park, Mich.

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Appendix

Process	*General Equation*	*Comment*
(I) *Material Balance*	First Law of Thermodynamics or Conservation of Mass	Readily solved if all data are available.

Generally the material balance for substance i in a given system may be written:

$$\frac{\partial M_i}{\partial t} = \sum_j m_{ij} + \sum_k G_{jk} \qquad \ldots\ldots \text{(Eq. I)}$$

where m_{ij} = mass rate of flow of substance i into the system by stream j,
G_{jk} = mass rate of generation of substance i in the system by process k.

If substance i is removed from the system by some stream or process, the sign on that term is negative.

Process	*General Equation*	*Comment*
(II) *Energy Balance*	First Law of Thermodynamics	Readily solved if all data are available.

The general energy equation for several streams may be written:

$$\sum m_j \left(\frac{u_j^2}{2g_c\alpha_j} - \frac{g}{g_c} z_j + i_j \right) = Q - W \qquad \ldots\ldots \text{Eq (II)}$$

m_j = mass of stream j
u_j = velocity of stream j
g_c = gravitational constant
g = gravitational acceleration
α_j = kinetic energy correction of stream j
z_j = height of stream j above reference level
i_j = enthalpy of stream j
Q = total heat added to system other than by the streams
W = total work done by the system other than on the streams

Process	*General Equation*	*Comment*
(III) *Phase Equilibrium*	Second Law of Thermodynamics	Readily solved if all data are available.

For an equilibrium system in which pressure is the only force acting

$$dF = -SdT + Vdp \qquad \ldots\ldots \text{Eq. (IIIa)}$$

where F = total Gibbs free energy of the system
S = total entropy of the system
V = total volume of the system
T = temperature of the system
p = pressure of the system

If the chemical potential of species i, μ_i, is defined as

$$\mu_i = \left(\frac{\partial F}{\partial N_i} \right)_{p,\, T,\, N_1 \ldots N_n} \qquad \ldots\ldots \text{Eq. (IIIb)}$$

where N_i = mols of i, then equilibrium exists when

$$\mu'_1 = \mu''_1 = \ldots\ldots = \mu^n_1$$
$$\mu'_2 = \mu''_2 = \ldots\ldots = \mu^n_2$$
$$\ldots \quad \ldots \quad \ldots$$
$$\mu'_N = \mu''_N = \ldots\ldots = \mu^n_N$$

where the superscripts distinguish between the various phases.

Process	*General Equation*	*Comment*
(IV) *Chemical Reaction Equilibrium*	Second Law of Thermodynamics	Readily solved if sufficient data are available.

For the general chemical reaction

$$aR_1 + bR_2 + \ldots \rightleftharpoons xP_1 + yP_2 + \ldots \qquad \ldots\ldots \text{Eq. (IVa)}$$

where a, b, ... and x, y, ... are the stoichiometric coefficients of the reactants R_1, R_2, ... and products P_1, P_2, ..., respectively, the equilibrium equation is

$$\frac{(\bar{a}_{P_1})^x (\bar{a}_{P_2})^y}{(\bar{a}_{R1})^a (\bar{a}_{R2})^b} = K_a = e^{-\frac{\triangle F^\circ}{RT}} \qquad \ldots\ldots \text{Eq. (IVb)}$$

where $\bar{a}$ = is the activity of the reactant or product in question
K_a = equilibrium constant, a function of temperature
$\triangle F^\circ$ = standard free energy change of the reaction
R = gas constant
T = absolute temperature

Process	*General Equation*	*Comment*
(V) *Chemical Reaction Rate*	Law of Mass Action	Mechanism frequently unknown. Often insufficient data. Equations often solvable.

The rate of a chemical reaction is given by the law of mass action. For the general reaction

$$aR_1 + bR_2 + \ldots \longrightarrow \text{Products} \qquad \ldots \text{Eq. (Va)}$$

The rate of the reaction is given by

$$-\frac{dC_R}{dt} = kC_{R_1}^{\ a} C_{R_2}^{\ b} \ldots \qquad \ldots\ldots \text{Eq. (Vb)}$$

where C_R is the concentration of any reactant, C_{R1}, C_{R2}, ..., are the concentrations of the respective reactants as functions of time and k is the reaction rate constant.

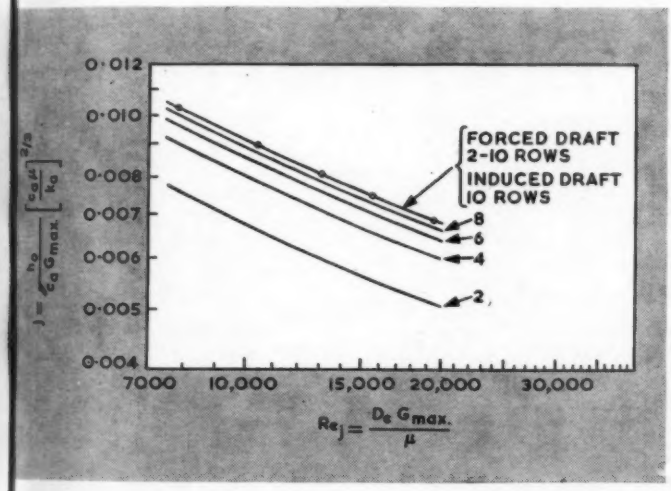

Fig. 9. Air heat transfer.

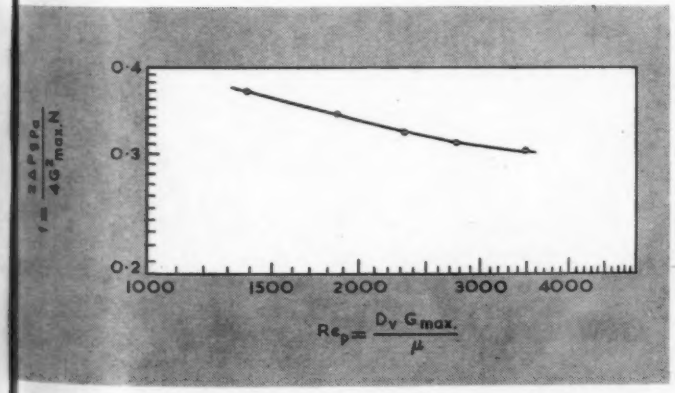

Fig. 10. Air friction factors.

	Process	General Equation	Comment
(VI)	*Fluid Flow*	Navier-Stokes Equations	Second order non-linear partial differential equations unsolvable in general. Many laminar solutions, very few turbulent.

Obtained by equating the rate of change of momentum of a fluid element to the sum of the forces acting on the element

$$\rho \frac{Du}{D\theta} = F_x - \frac{\partial p}{\partial x} + \frac{\partial}{\partial x}\left\{\mu\left[2\frac{\partial u}{\partial x} - \frac{2}{3}\left(\frac{\partial u}{\partial x} + \frac{\partial v}{\partial y} + \frac{\partial w}{\partial z}\right)\right]\right\} + \frac{\partial}{\partial y}\left[\mu\left(\frac{\partial u}{\partial y} + \frac{\partial v}{\partial x}\right)\right] + \frac{\partial}{\partial z}\left[\mu\left(\frac{\partial w}{\partial x} + \frac{\partial u}{\partial z}\right)\right] \quad \ldots\ldots \text{Eq. (VIa)}$$

plus two equations obtained by cyclic permutation of (x, y, z) and (u, v, w) plus the equation of continuity

$$\frac{\partial \rho}{\partial \theta} + \frac{\partial(\rho u)}{\partial x} + \frac{\partial(\rho v)}{\partial y} + \frac{\partial(\rho w)}{\partial z} = 0 \quad \ldots\ldots \text{Eq. (VIb)}$$

where $\frac{D}{D\theta} = \frac{\partial}{\partial \theta} + u\frac{\partial}{\partial x} + v\frac{\partial}{\partial y} + w\frac{\partial}{\partial z}$ is the particle or substantive derivative

p = pressure
x, y, z = orthogonal (Cartesian) co-ordinates
u, v, w = velocities in the x, y, z directions, respectively
ρ = density
μ = viscosity
F_x = gravitational force

	Process	General Equation	Comment
(VII)	*Mass Transfer-Molecular Diffusion*	Fick's Law	Second order non-linear partial differential equation unsolvable in general but many important restricted cases have been solved.

This case is controlled by the general form of Fick's Law:

$$\frac{\partial C_i}{\partial \theta} = \frac{\partial}{\partial x}\left(D_i \frac{\partial C_i}{\partial x}\right) + \frac{\partial}{\partial y}\left(D_i \frac{\partial C_i}{\partial y}\right) + \frac{\partial}{\partial z}\left(D_i \frac{\partial C_i}{\partial z}\right) + G_i \quad \text{Eq. (VII)}$$

where C_i = concentration of component i
D_i = diffusion coefficient for component i
G_i = generation rate (as a result of a chemical process) of component i.

	Process	General Equation	Comment
(VIII)	*Mass Transfer-Convection Diffusion*	Modified Fick's Law + Navier-Stokes equations	Second order non-linear partial differential equations unsolvable in general.

For this case, it is necessary to modify Fick's Law to allow for convective transport, giving

$$\frac{\partial C_i}{\partial \theta} = \frac{\partial}{\partial x}\left(D_i \frac{\partial C_i}{\partial x}\right) + \frac{\partial}{\partial y}\left(D_i \frac{\partial C_i}{\partial y}\right) + \frac{\partial}{\partial z}\left(D_i \frac{\partial C_i}{\partial z}\right) - \left(u\frac{\partial C_i}{\partial x} + v\frac{\partial C_i}{\partial y} + w\frac{\partial C_i}{\partial z}\right) + G_i \quad \text{Eq. (VIII)}$$

where u, v, w = instantaneous velocities in x, y, z directions. These are given by the Navier-Stokes equations. In engineering calculations usually more convenient to use time-average velocities and an eddy diffusivity to allow for turbulent diffusion.

	Process	General Equation	Comment
(IX)	*Heat Transfer-Conduction*	Fourier's equation	Second order non-linear partial differential equations, unsolvable in general but most restricted cases of common interest have been solved.

The general equation governing this case was first established by Fourier (see Eq. (IX) in Part I):

where c_p = specific heat
ρ = density
t = temperature
k_x, k_y, k_z = thermal conductivities in x, y, z directions, respectively
G = volumetric internal heat generation rate.

The similarity between this and the general Fick's Law equation is readily seen.

	Process	General Equation	Comment
(X)	*Heat Transfer-Conduction and Convection*	Modified Fourier's equation + Navier-Stokes equations	Second order non-linear partial differential equations, unsolvable in general. A few special cases have been solved.

Fourier's equation (Eq. (X)) may be modified to apply to this case (see Part I). As in diffusion with convection, u, v, and w may be taken as instantaneous velocities obtained from the Navier-Stokes equations, or modified to use time-average velocities and eddy conductivities for turbulent flow.

	Process	General Equation	Comment
(XI)	*Heat Transfer-Radiation*	Quantum mechanics	Chief difficulty is that interaction between matter and radiation is not well understood on the practical level.

The basic equations of radiation from black bodies are due to Stefan and Boltzmann

$$E_b = \sigma T^4 = \int_0^\infty E_{\lambda b} d\lambda \quad \ldots\ldots \text{Eq. (XIa)}$$

and Planck

$$E_{\lambda b} = \frac{C_1 \lambda^{-5}}{\exp\left(C_2/\lambda T\right) - 1} \quad \ldots\ldots \text{Eq. (XIb)}$$

where E_b = total energy radiation rate per unit area of a black body
$E_{\lambda b}$ = energy radiation rate of wave length per unit area of a black body
σ = Stefan-Boltzmann constant
T = absolute temperature
λ = wave length of radiation
C_1, C_2 = quantum radiation constants.

For real materials, corrections must be made for the fact that black body behaviour is not followed. When two or more surfaces are present, the calculation of net transport is usually tedious.

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PLANNING THE WORK OF A DESIGN GROUP

How a Chemical Plant Design Group can meet completion dates and keep within the cost estimates

by M. DAVIDMANN, B.Sc.*

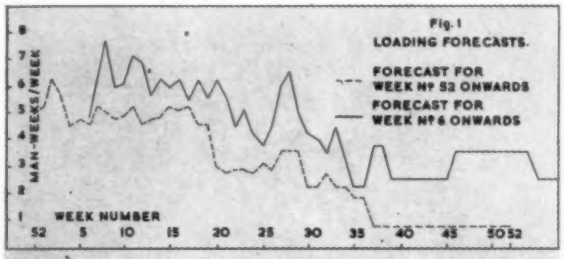


Fig. 1
LOADING FORECASTS.
FORECAST FOR WEEK No 52 ONWARDS
FORECAST FOR WEEK No 6 ONWARDS
MAN-WEEKS/WEEK
WEEK NUMBER
52 5 10 15 20 25 30 35 40 45 50 52

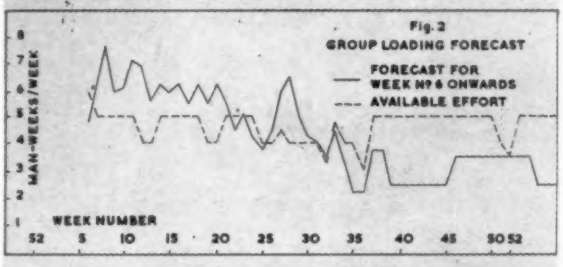
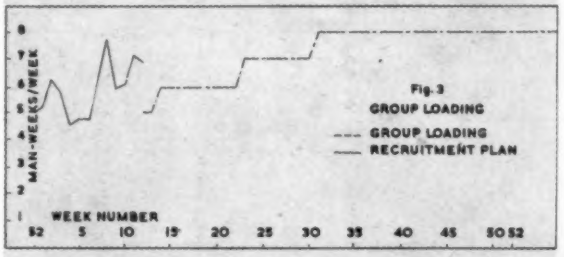


Fig. 2
GROUP LOADING FORECAST
FORECAST FOR WEEK No 6 ONWARDS
AVAILABLE EFFORT
MAN-WEEKS/WEEK
WEEK NUMBER
52 5 10 15 20 25 30 35 40 45 50 52



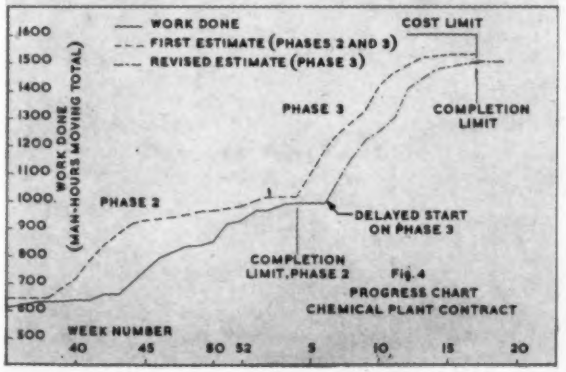


Fig. 4
PROGRESS CHART
CHEMICAL PLANT CONTRACT

THE chemical plant contractor has to hand over the plant he has designed, manufactured in part, erected and operating to his customer's satisfaction by a promised date. At the same time, he has to operate within the limits set by his cost estimate. The various work units which constitute the contracting organisation work together to achieve these ends and a method by which they can do this effectively has been described.[1] As a rule, in the case of design work, each design group is responsible for its own expenditure and timing.

In order that design work can be carried out so that cost and timing limits are not exceeded, a system such as that described here is required. Although this system applies equally well to other design groups, it is discussed and illustrated here with reference to the group which carries out chemical engineering design.

The Basis

A plan must include an estimate of how the amount of work, and the rate at which it is done, varies as the project progresses. At the time the plan is made, it must provide the best possible estimate, taking into account the total situation as then seen.

Managers then make decisions which take this situation into account. One decision may be to concentrate work on one project rather than another, should the necessity arise. The need for such a policy decision has to be appreciated at a time when it is still possible to take corrective action without endangering other work, and the decision has to be based on the most comprehensive view of the total situation that can be obtained. The comparison between plan and actual work completed reveals this need and provides the basis for the decision. Once the decision has been made, the plan has served its purpose. The decision in itself alters the plan, which thus changes as the total situation changes.

A work plan will contain limits, examples being target dates and allowed costs. As long as these limits are not exceeded, the plan may be varied at the discretion of the manager concerned. Should the limits be in danger of being exceeded, then the policy decision has to be made either at the next higher management level or by the manager, following discussion with the relevant group.

Policy, as laid down by the board of directors, can be considered a statement of general long-term aims for the organisation as a whole. When this policy is put into effect, it is interpreted differently at successively lower levels within the organisation. The lower the level, the smaller is the area of activity, the greater the detail and

the smaller the time-span. Planning of work has thus to be adapted to the level at which it is applied.

A general overall plan for a wide area of activity is required at one level, a more detailed plan covering a smaller specific area of activity at the next lower level. The two plans should not be regarded as separate and independent of each other. The general policy statement at level A determines in outline the plan for the next lower level B. The resulting detailed plan for level B affects the plan at level A.

The plan thus has to point out the need for a policy decision and to provide the basis for making the decision. It has to be flexible in order to meet changes in the entire situation. It has to be adapted to the level at which it is applied.

The planning system proposed is based upon estimates. Seldom does a project run according to initial rate estimates. Policy decisions have to be taken. The system is dynamic, in that it points out the need for such decisions. Being but an aid to management, it is not a substitute for it. The system of work planning described here enables the manager to plan ahead effectively, within the framework of general policy determined by his own executive superior. It also enables him to determine the extent to which policy is being carried out and to compare results against forecasts. It enables his subordinates to plan and carry through the work for which they are responsible. Also, it provides factual data for increasing accuracy of estimates and forecasts and for determining that part of the work where improved effectiveness would produce most gain.

The Group

The name given to any particular work group should clearly reflect its work. Mechanical engineers work in Mechanical Design Group and carry out mechanical design. The name, associated with the function of the group, assists the individual in visualising its work. No clear picture is brought to mind by names given to chemical engineering design groups such as, for example, Process Design Group or Chemical Design Group. It is therefore proposed to call the group doing this work the Chemical Plant Design Group.

The head of the Chemical Plant Design Group bears the title Chief Chemical Engineer. From a technical point of view, he is responsible for chemical engineering development and chemical engineering design, for commissioning and proving, for satisfactory operation and performance of the plants designed by his engineers. As a manager, the Chief Chemical Engineer has, amongst other responsibilities, the task of ensuring that work in his group is planned so that it is carried out effectively, taking into account limits set on costs and timing.

Estimating Department is responsible for estimating costs and would have received, from the design group, an estimate of design effort required, at the pre-quotation stage. As soon as the order is received, Estimating Department tell the design group the design cost included in the estimate. Planning Group is responsible for estimating the completion date and would have received an estimate of time required for design work and its starting date. Again, as soon as the order is received, Planning Group issue to the design group the timing chart which indicates the completion dates for the work, upon which the overall delivery date is based. The design group, knowing both the allowed cost and the allowed time, now has the information for planning its work.

The initial design work for a chemical plant contract is carried out by the chemical engineers, so that delays on their part immediately affect other groups and departments. To enable the head of the Chemical Plant Design Group to plan ahead, he must know at the earliest possible moment that an order has been or is about to be placed and requires quickly to receive the relevant data from Estimating Department and the Planning Group. His work comes also when the contract is almost completed, and then his own work is affected by delays caused by other groups and departments. To plan ahead he must be told regularly by the Planning Group how actual progress is likely to affect his work. Note that information on costs and timing is being passed to the design group, but that it is the design group which is responsible for its own expenditure and work planning.

Accounts Department have to receive a statement of man-hours worked on each project, so that they, in turn, can report back the up-to-date design cost. We are not here concerned with returns made by the design group to other groups or departments, but it is possible that the report from Accounts Department will be received too late for effective action to be based on it. In that case a policy decision is required; namely, should Accounts Department provide the information at the required speed, or should the analysis be done by the design group? In the latter case, to avoid duplication of work, the data required by Accounts Department would be supplied by design group, summarised for the group as a whole. The system described here assumes that the design group carries out its own analysis, on the assumption that the total man-hours spent on any particular project gives a sufficiently accurate indication of cost, the difference in cost of work done by senior and junior engineers being neglected. It could, however, have been based equally well on more exact cost returns from Accounts Department, had this been thought necessary.

To return to Chemical Plant Design Group, the Chief Chemical Engineer has organised his group into a number of specialist sections, and he has delegated responsibility for work planning to the head of each section. The head of such a section is here, for ease of reference, called the "manager", his subordinates being referred to as "engineers". Each engineer is responsible to the manager, amongst his other responsibilities, for giving and/or maintaining cost and work-completion estimates and for planning his own work accordingly. The engineer points out to the manager the need for a policy decision. He keeps the manager informed on progress, difficulties and delays.

The Work

The work of the engineer may be classified as follows:

(1) Enquiries;
(2) Contracts;
(3) Development;
(4) General.

It should be noted, in passing, that the term "project" is taken as referring to any main work task, no matter under which heading it is classified, and also that we are not here analysing administrative work. The work analysed is that of the engineer, who spends most of his time on work tasks which can be classified under headings (1), (2) and (3).

The work done for inquiries includes design work as well as technical discussions which are generally required so as to assist the prospective customer in defining the most suitable plant for his purpose. Also, an estimate has to be made of required effort. By estimate of effort is meant an estimate, for each work task, of:

(a) volume of work, that is, man-hours required for completion of work task;
(b) start and duration of effort, that is, start and time-span required for completion, allowing for dependence on other works groups and work tasks; and

(c) intensity of effort required each week.

Keeping a check on how an inquiry is progressing, as distinct from work planning to meet limits, is not discussed here, but a note is kept of when the inquiry was received, when work was completed, when the quotation was sent to the customer and of its value, and also of Sales Department's follow-up visits. Sales Department arrange technical follow-up visits at either the customer's or Chemical Plant Design Group's request.

Contract work includes the necessary detailed design work, advising other groups and departments, preparing flowsheets and operating instructions, commissioning and proving, and associated reporting.

"General" work includes such items as work analysis, project analysis, training and attendance at professional meetings. As it is work which cannot directly be allocated to any one project, it can conveniently include such items as illness, leave, statutory holidays and absence for personal reasons, as well as late-coming or not settling down to work at any particular time.

Each engineer works a 40-hour working week and, as a first approximation, we take the effective effort available from him as being 35 man-hours, that is, $\frac{7}{8}$ man-weeks/week, allowing separately for holidays and leave. The effective effort available is the difference between normal working hours and time accounted for by general work.

For accounting purposes, "general" work can be carried as an overhead charge. It is of some value, although by no means necessary, thus to separate out the general work content, when both small and large projects are being handled at the same time, there being some indication that otherwise larger projects carry a disproportionate part of this charge.

The System

Loading Forecasts

The loading forecast is an estimate of the anticipated future work load, that is, of required effort which can be foreseen.

Each engineer prepares an estimate of future effort required for the projects for which he is responsible, allowing for work content and target dates which may have been previously agreed. How far ahead he can plan depends on the type of work he does and on his level within the organisation, but the forecast is made for each week up to between three months and a year ahead. He distinguishes between development, inquiry and contract work, breaking down the work for each project into individual work tasks. His forecast is made in the form of a table. How quickly it is revised depends on how quickly the situation changes.

The manager prepares a more general forecast based on those received from his engineers. His forecast, again in tabular form, indicates the estimate for each project, under the categories of development, inquiries, contracts. Not only should each engineer's load be reasonably even, but also that for the group as a whole. It is in preparing this forecast that the manager, in discussion with his engineers, anticipates periods of light and heavy loading. He levels out the work distribution, considering both expected and existing projects. He also considers how policy can be carried out as regards division of work between the categories and considers possible staff changes that may seem indicated. He will look further into the future and his forecast covers a longer time-span than the engineers' forecasts.

The manager's forecast forms the basis for the work of the group in the immediate future. It is built up from the individual forecasts he has agreed with his engineers. Its main use is for planning ahead.

Work Plans

Each engineer prepares his work plan from the forecast he has agreed with his manager. It indicates when work is expected to start on any part of a particular project and by when it has to be completed. In other words, it clearly indicates the anticipated duration of effort as well as target dates.

The work plan enables each engineer to see how work is proceeding as regards timing. He is thus in the position either to make up lost time or else to see when it is necessary to approach his manager to point out the position and to ask for a policy decision.

The work plan gives no information on either the volume of work or on the intensity of effort allowed for individual work tasks or projects. This information is depicted on project progress charts.

Work Records

Each engineer keeps a daily informal record of how he has spent his time. He divides this record into the four main categories of development, inquiry, contract and general work. Each project is separately recorded and divided into individual work tasks.

The record for the week is entered up at the end of each week on the engineer's work record form, which covers a period of thirteen weeks. This work record provides the basic data for bringing up-to-date the work plans and project progress charts.

Progress Records

The anticipated, or allowed, volume of work and intensity of effort has already been agreed between manager and engineer, as recorded on the loading forecast. This is used to draw a progress chart for each project, consisting of a plot of the estimated moving total of effective man-hours expended against time. On these charts are entered target dates and any limits which should not be exceeded, such as, for example, a work content equivalent to the cost agreed previously with Estimating Department.

The effective man-hours worked on each project is extracted from work records and the up-to-date moving totals are plotted on the progress charts. The charts are brought up to date once a week or once a fortnight, as the need may be. The graph of actual effort expended does not usually correspond with the estimated curve, and indeed it is the difference between anticipated and actual work which is of importance.

Each progress chart indicates how the design group's rate of progress compares with estimated rates, both for cost and for timing. The charts are drawn up not only for contracts, but also for work on inquiries, for development work, for individual projects and/or for the category as a whole.

The Application

The system is discussed with those concerned, modified in detail, where necessary, to suit local conditions, and put into effect.

The extent to which statistical and clerical work is done locally, and how this is to be done, is one of the points to be determined before the system is put into effect. The records and charts are available to those who compile or need to consult them. They are brought regularly to the attention of those who need to see them.

Those who operate the system can judge how effective it is in enabling them to carry out their responsibilities. It is made clear that any engineer or manager should, once some experience in operating the system has been gained, propose to his own immediate superior such modifications as would, in his opinion, increase the effectiveness of the system.

The engineer prepares his loading forecast and his work plan at relatively infrequent intervals. He keeps a detailed record of the way he has divided his time between different work tasks and enters this information on his work plan. The keeping of these routine records usually takes up less than one and a half hours each week of each engineer's time. His tools are his work plan and the project progress charts with which he is concerned and on which he notes any matters which have affected progress or cost.

The manager regularly reviews project progress charts and his overall forecast. His tools are those charts which are based on loading forecasts and the project progress charts.

In between recording the data and the progress charts lies the statistical work of analysing the work record sheets to obtain the weekly data in useful form.

The Records

The records used for planning are:

(a) Loading forecasts;
(b) Work plans;
(c) Work records;
(d) Progress records.

As these records relate to the work being done by the manager and his team of subordinates, they have immediate meaning to those concerned.

Loading Forecasts

Fig. 1 illustrates the overall loading forecast for the group. Two successive forecasts are shown, made at an interval of about six weeks. The situation has changed considerably during these six weeks but, even so, one might judge that the load will be considerably reduced after six months or so, and that the group would then be looking for work. However, the way in which such forecasts can assist forward planning is illustrated by Figs. 2 and 3, derived from Fig. 1.

Fig. 2 shows the then up-to-date loading forecast. Plotted to the same scales is a graph of the available effort which can be applied by the group. This allows for known staff changes, for leave and for statutory holidays. Planned recruitment is not taken into account and engineers are included only after they have been with the group for one or two months. This chart is used for forward work planning, that is, for fitting in new work. It indicates in this case that the group ought not to accept new work which has to be done during the first nine months from the date of making the loading forecast, should its strength remain at a constant level.

The second type of chart used for forward planning, illustrated by Fig. 3, shows the actual loading of the group. Loading forecasts are made here at intervals of six weeks and the loading estimate for the first six weeks of each forecast is assumed to be an accurate representation of the work load for the group as a whole. These estimates are then plotted consecutively and the graph drawn represents the loading of the group. The first six weeks' load estimates from each of the forecasts given in Fig. 1 are plotted in Fig. 3 to show the group loading, and it is seen that the work load is increasing steadily. On the basis of this graph the forward recruiting plan is prepared and this is plotted on the same chart.

In the example illustrated here the loading forecast seemed to give the impression that the group would be underloaded within about six months or so. In fact, the work capacity for the first nine months had already been reserved in advance at the time the estimate was made, and the work load was steadily increasing. Hence it is charts such as those illustrated by Figs. 2 and 3 which are used for forward planning.

The ordinate on these charts has units of man-weeks/

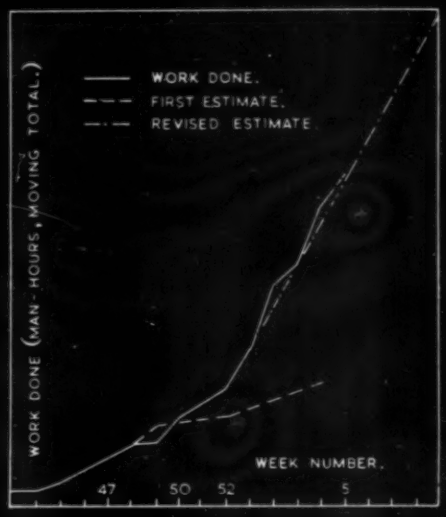


Fig. 5

week, whether general work is included or not. This is of no concern, as long as general work is consistently included or excluded and as long as the appropriate conversion factor is used for converting man-hours to man-weeks.

Work Plans

The work plan is no more than the normal project bar chart, itemised in accordance with the engineer's loading forecast. Anticipated duration is shown in black; actual work carried out is entered up in green.

Work Records

The work record sheet is illustrated by Fig. 6. It is a simple blank form which enables the engineer to enter up his own projects and to subdivide his work into suitable work tasks, as required.

Progress Records

Fig. 7 illustrates a project progress form. The total work done by the group on each particular project is recorded weekly on such a form, and these forms are used to bring up to date the project progress charts. Note that the distinction between individuals has almost disappeared. Although work done by senior and junior engineers is separately recorded, the data are already that for a project.

The progress charts, and the use to which they are put, are illustrated by Figs. 4 and 5. Fig. 4 gives the data for a medium-sized chemical plant, Fig. 5 that for a complete category such as work done on development.

Fig. 4 gives the estimate made in week 33 for phase 2 and phase 3 of the particular project used as example. In making the estimate, account was taken of time and effort allowed for completion, and also of the available man-power, in the way already described. Four weeks had passed after the estimate had been made, and when work was to have started on phase 2 the situation had changed so that a policy decision was required to decide whether effort should be concentrated on this project or on another. Work on phase 2 had to be completed before starting work on phase 3. The work done by other groups was not affected by delay, as long as work on phase 2 was completed by the end of week 4. The decision was therefore made to concentrate work on the other project, but to ensure that this project would not be delayed as a result. Fig. 4 clearly shows how this decision was effectively implemented. There is the initial delay with comparatively little work done on this project, followed by an intense effort to get

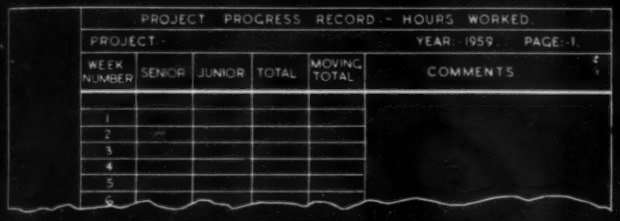
WORK RECORD - HOURS WORKED

NAME -

YEAR - 1959 PAGE - 1

PROJECT	WORK TASK	"WEEK ENDING" AND "WEEK NUMBER"												
		4.1.59	11.1.59	18.1.59	25.1.59	1.2.59	8.2.59	15.2.59	22.2.59	1.3.59	8.3.59	15.3.59	22.3.59	29.3.59
		1	2	3	4	5	6	7	8	9	10	11	12	13

Fig. 6

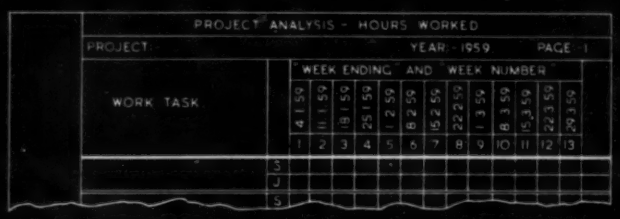

PROJECT PROGRESS RECORD - HOURS WORKED

PROJECT -

YEAR - 1959 PAGE - 1

WEEK NUMBER	SENIOR	JUNIOR	TOTAL	MOVING TOTAL	COMMENTS
1					
2					
3					
4					
5					
6					

Fig. 7


PROJECT ANALYSIS - HOURS WORKED

PROJECT -

YEAR - 1959 PAGE - 1

WORK TASK		"WEEK ENDING" AND "WEEK NUMBER"												
		4.1.59	11.1.59	18.1.59	25.1.59	1.2.59	8.2.59	15.2.59	22.2.59	1.3.59	8.3.59	15.3.59	22.3.59	29.3.59
		1	2	3	4	5	6	7	8	9	10	11	12	13
	S													
	J													
	S													

Fig. 8

Fig. 5 PROGRESS CHART DEVELOPMENT WORK

Fig. 6 ARRANGEMENT OF WORK RECORD CHART

Fig. 7 ARRANGEMENT OF PROJECT PROGRESS RECORD

Fig. 8 ARRANGEMENT OF PROJECT ANALYSIS FORM

the bulk of the work done. This, in turn, is followed by another quiet period while work is proceeding on the other project, with the subsequent final spurt to get the work completed. The task was, in fact, completed two weeks before the set limit and at a little less effort than had been estimated. Work on phase 3 was started two weeks late, the delay having been caused by another group not completing its work on time. Hence as soon as work could be started the original estimate was replotted, allowing both for the two weeks' delay and for the small saving in effort. The work as a whole is running two weeks late, the effect on the final set limit being clearly shown; but as the estimate relates only to work done by this particular group, it is not altered in any way either in intensity of effort or in time-span to allow for delay caused by the other group. However, an effort will be made to make up the lost time, if at all possible, and its success or otherwise will in due course be clearly shown by the black graph of actual effort expended.

Fig. 5 shows an estimate of effort made in week 48. Again, within four weeks the situation had altered owing to a decision to follow up in strength a promising development. A revised estimate was made during week 1. In this case also it was the estimate which was altered, the revised estimate showing how the new policy could be implemented. Agreement between actual and estimated effort is deceptively good, but it was the available man-power which limited the intensity of effort and this was known at the time the estimate was made.

A colour code can be used to indicate the comparison with the original estimate, but it is usually sufficient to give a green line for the estimate, a black line for actual effort, the difference between them being marked in red when the work is late and in green when the work has been completed within the estimate.

Other colours could be used to show when the estimate was too low and for the case when, in addition, the work has been delayed.

Analysis of Records

At the end of a project the completed work record sheets are analysed in two ways, as required. First, factual data are summarised for each project so as to provide a background of correlated data enabling the accuracy of estimates of design content to be continually improved. Secondly, criteria of performance can be extracted which point to that part of the work where effectiveness can be improved with greatest gain.

Project Analysis

The detailed data for each project are transferred from work records to project analysis forms. Again, the forms record separately the work done by junior and senior engineers. The form is illustrated by Fig. 8.

At the completion of each project, the analysis is completed by summing up the effort expended on each work task within the project. For smaller projects a simple table suffices to present the overall picture. This gives, against each work task, the time-span and the intensity of effort, as well as the percentage of the total effort for the project as a whole which the particular work task represents. At the same time, notes are added which describe the project in general terms, also giving its money value, and any points worth noting, especially such as, for example, that one particular work task was wholly caused by a change of mind half-way through the project. At times progress on a particular project may be limited by available man-power and this also would be noted. Hardly any two projects are exactly alike and these notes should give sufficient information to enable the data for this project to be applied to another similar one.

For larger projects a similar table with accompanying notes is used for summing up, but a single-colour bar chart is used for recording time-span. This is the project bar chart and it records fact, not forecast.

Once analysed, the project records, which include also progress records and progress charts, are filed and kept for future reference. This is done only after original estimates of design costs and time-span have been compared with actual costs and time-span, this comparison being recorded. The records serve to improve the reliability of forward estimates, for example, for Estimating Department and for Planning Group in connection with inquiries.

Work Analysis

When required, criteria of performance may be extracted from the project records. For example, the greater the percentage of the total work devoted to any particular work task, the greater the reward to be gained by increasing the effectiveness of work on that task. Another example is the percentage of the effort expended on any particular work task, or indeed on the project as a whole, by senior as compared with junior staff. This reflects inexperience on the part of junior staff, staff turnover, novel nature of work task, or the degree to which responsibility is being delegated.

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661.715.3(428)

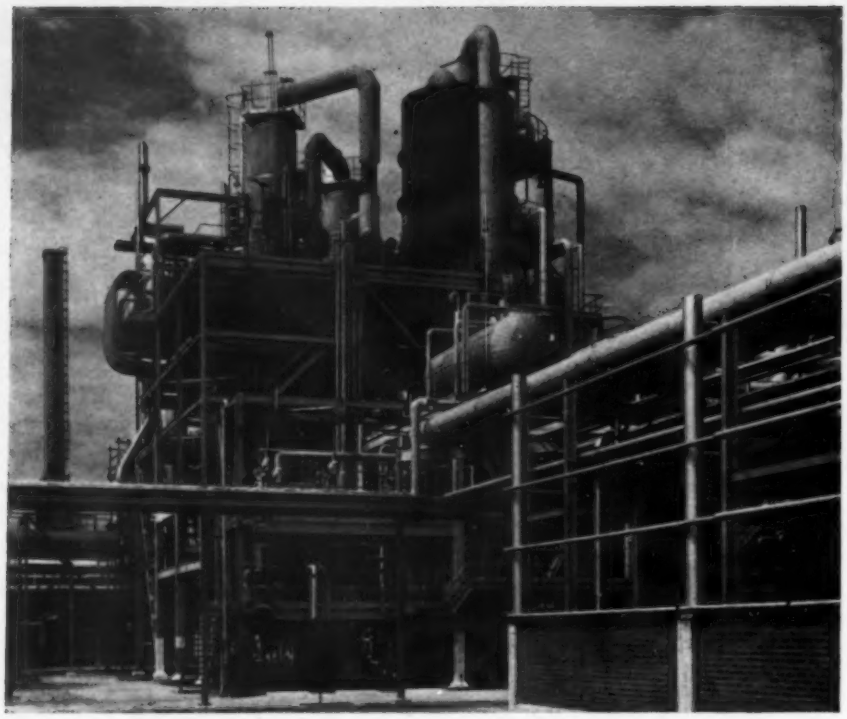

Fig. 1. General view of primary fractionator.

ICI's PETROLEUM CHEMICALS COMPLEX —LARGEST OUTSIDE THE U.S.A.

Happily coinciding with the tenth anniversary of the I.C.I Wilton Works, No. 3 Olefin Plant, described below, recently came on full stream

THE inter-linked group of I.C.I. plants at Billingham and Wilton represents one of the largest concentrations of chemical industry in the world and employs 25,000 people. Now that the third olefin plant—capable of handling ¼-m. tons annually of feedstock—has been brought on stream, the Olefin Works and associated factories form the largest petroleum chemical venture outside the U.S.A. and the largest anywhere using liquid feedstock. This third and largest stage of the group of olefin plants has raised the total olefin capacity by 60%. Current output is 110,000 tons a year and can be fairly readily increased to 140,000 tons a year. Due to extensive use of automatic controls, the expansion required an increase in normal process staff of only 13 men a shift controlling a total of 13,000 hp. In essence, the No. 3 olefin plant employs the same processes as those operated since 1951 by I.C.I. for ethylene production at Wilton. The plant is broadly divided into the pyrolysis section and the product separation and purification section.

Feedstock and Primary Products

Ethylene contains 14.3% by weight of hydrogen. This implies that a light hydrocarbon feedstock with high hydrogen content is desirable. At present, a number of considerations have restricted the choice to a light naphtha known as light distillate 2. This is derived from paraffinic crude oils, and is essentially a mixture of hydrocarbons in the C_4-C_9 range. The plant has, however, been designed to operate with more than one type of light distillate, to give some flexibility in dealing with supplies. Direct products are ethylene and propylene of high purity, methane, ethane, "tail gas" consisting of hydrogen and methane, butylenes plus butadiene, gasoline of high octane number, and fuel oil. Because of the favourable conditions of pyrolysis and the high temperature, the ethylene is produced at relatively high concentration and at a high ratio to ethane. Also, propylene and butadiene are produced in high proportion to propane and other C_4 hydrocarbons respectively. No large-scale storage facilities exist at Olefin Works for the storage of ethylene and propylene, which are fed to their next process stage by pipeline.

A representative composition by volume of the gases—other than steam—issuing from the cracker is as follows:

Hydrogen	15.0%
Methane	28.1%
Ethylene	31.2%
Ethane	5.0%
Propylene	13.7%
Propane	0.6%
C_4-products	6.4%
	100.0%

Plant

The pyrolysis section of No. 3 olefin plant consists of three independent parallel systems, each with its separate tubular oil heater, tubular steam superheater, soaker line and quench boiler. In the latter, 250 psig steam is generated as the reaction is quenched—temperature being reduced to 350°C. Each system is independent, giving flexibility in regulating pyrolysis conditions at different rates of naphtha feed.

To produce the maximum amount of olefins, the feedstock should be cracked at low partial pressures with low residence times in the reaction zone. These requirements are met in the Kellogg method of pyrolysis by mixing hot hydrocarbon vapour with steam at the still higher temperature of over 900°C. It is thought that the steam plays no chemical part in the reaction, but the mechanism is still being investigated. Most of the pyrolysis then occurs in a length of internally insulated pipe (the soaker), which leads to the quench devices. Here the reaction is "frozen" after a contact time of the order of only one second. This pyrolysis arrangement is reported to have three advantages. It enables high pyrolysis temperatures to be achieved without risk of coke formation. Secondly, gasoline of high octane rating can be separated from the liquid products; finally, it is possible to vary the ratio of steam to hydrocarbon and thereby obtain a degree of flexibility in product distribution, in particular in the ratio of production of ethylene to propylene.

Products of pyrolysis go on to the primary fractionator where the small amount of heavy polymeric oil is separated from the gas and crude petrol and used subsequently as fuel oil. The steam is also condensed at this stage and separated. The gas and steam then goes to the gas separation section. This comprises a compression unit for process gas and refrigeration purposes; a purification unit where hydrogen sulphide, water and acetylene are removed from compressed process gas; a warm fractionation system yielding a side-stream where petrol and butylenes plus butadiene are separated; and finally a train of fractionating columns operating at low temperature in which the remaining light hydrocarbon products are separated from the main stream.

Fig. 2. View of overhead condensers, in association with primary fractionator and soaker lines.

From the warm fractionation unit the butylenes/butadiene stream is washed with caustic before transfer to other plants, while the petrol is transferred to the gasoline treatment plant, where it is treated in combination with the petrol streams from the other two olefin plants.

Methane, ethylene, propylene and ethane from the purified gases are separated by low-temperature refrigeration and fractional distillation under medium pressures, but certain modifications are incorporated in the No. 3 plant. Refrigeration is provided by a propylene compression system and by a two-stage ethylene compression system in cascade with it. Finally, the methane and lighter gas are separated.

Novel Features

This is probably the first time that a battery of free piston gas generators have been applied industrially. Here they drive the gas expansion turbines for the many centrifugal gas compressors used in the unit. At present they are running on gas oil generating gas at 450°C and 45 psig, but it is intended to run them on heavy fuel oil. In addition, there is the new demethanisation process, where nearly 100% pure methane—a new product at Wilton—is produced while a costly stage of refrigeration is eliminated. In order to reach the lowest temperature require for separation of methane and lighter gas, the methane product is let down in pressure and evaporated, instead of being subjected to a further stage of refrigeration compression.

Control and Safety

In the three olefin plants there are altogether 36 continuous and fully-automatic analysis instruments transmitting their readings to recorders in the control rooms. Non-dispersive infra-red spectrometers of British and American manufacture are used extensively for the analysis of simple mixtures of light hydrocarbons. For more complex compositions and low concentrations, a chromatograph or an instrument employing chemical analysis is used. In addition to automatic analysers, a considerable staff is engaged in the laboratory on analysis concerned with control of the unit and the checking of product purities. Here, again, full use is made of modern instruments such as mass spectrometers and chromatographic analysers. Most of the control is carried out by pneumatic instruments, but electronics are applied in the chemical analysis.

The Olefin Works plants pay great attention to matters of safety and the accident rate is very low. The low-temperature fractionation sections of the olefin plants have fire walls surrounding them completely; a blanket of steam can be rapidly laid around each enclosure to disperse a gross leakage of hydrocarbon vapours. A further precaution is the pressurisation of control rooms to obviate the risk of vapour accumulation within them. No process materials are led into control rooms; the opening and closing of valves from the control rooms is done by distant control. All the normal precautions of fire warning and so on are, of course, included, and their efficiency is constantly under review.

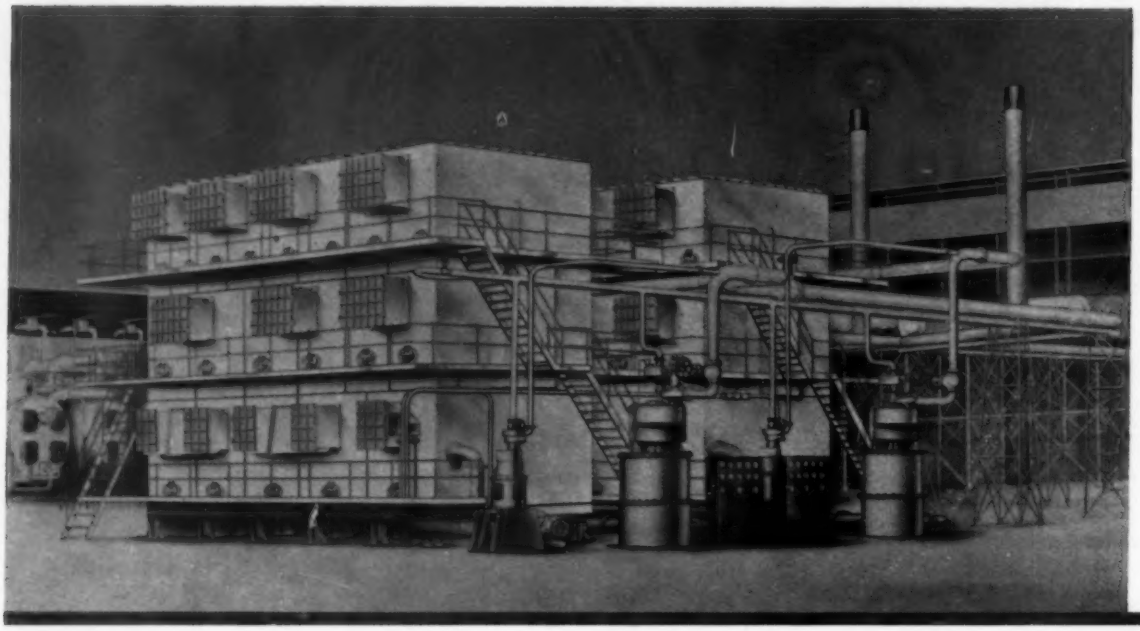

Fig. 1. An impression of the Weir "Multiflash" sea-water distillation plant ordered by the Government of Kuwait.

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PART III* LARGE-SCALE DEMINERALISATION OF SEA AND BRACKISH WATER

THE theoretically minimum energy requirement for the production of pure water from sea water is 2.85 kWh per 1000 U.S. gal. This very low figure applies to an idealised reversible process in which all driving forces are reduced to zero.[1] Since driving forces determine equipment sizes, reversible processes of the kind implicit in the calculation of the theoretically minimum energy requirement can be carried out only in equipment of infinite size for any finite production rate, or with a zero production rate for any plant of finite size. The first of these alternatives is clearly impossible, while the second is pointless. One is led to the conclusion, therefore, that in order to produce demineralised water from sea water in a physically feasible plant, one is obliged to use finite driving forces which lead to energy requirements substantially higher than the theoretical minimum. Any attempt to reduce energy requirements by approaching the ideal case more closely will inevitably lead to higher capital costs, unless at the same time some means are found to increase the rate coefficients characteristic of the particular separation process under consideration.

The above ideas become clearer when applied to a distillation process such as the usual vapour-compression cycle. In this cycle, as well as in any distillation process, the capacity of a plant is directly proportional to the quantity of heat transferred across the surface of the heat exchanger per unit time. This quantity is given by the usual equation of heat transfer:

$$Q = UA\Delta t \qquad \ldots.(1)$$

where Q = quantity of heat transferred, Btu/hr;
U = overall coefficient of heat transfer, Btu/hr °F ft²;
A = area of heat exchanger, ft²; and
Δt = temperature difference across heat exchanger surface

For any fixed value of the capacity, Q, and the rate coefficient, U, a decrease in the size (and therefore cost) of equipment, A, means an increase in Δt. This increase in Δt can be obtained only by increasing the pressure of the steam, i.e., by increasing the work of compression and therefore the energy requirement of the cycle. Depending on the costs of energy and of heat exchangers, there exists an optimum set of values of A and Δt; however, a relatively simple calculation will show that unless the rate coefficient, U, has certain relatively high values, the usual vapour-compression cycle leads to costs considered unacceptable for the large-scale demineralisation of sea water, even with the optimum combination of $A\Delta t$.

Neglecting the slight differences between the inside and outside surface areas of a heat exchanger tube, the overall coefficient of heat transfer may be expressed by

$$\frac{1}{U} = \frac{1}{h_b} + \frac{1}{h_s} + \frac{1}{h_f} + \frac{x}{k} \qquad \ldots.(2)$$

where h stands for the individual film coefficients, the subscripts b, s, and f refer to the brine side, steam side and scale film coefficients respectively, and $\frac{x}{k}$ is the

* Part I: April, 1959, p. 194; Part II: October, 1959, p. 516.

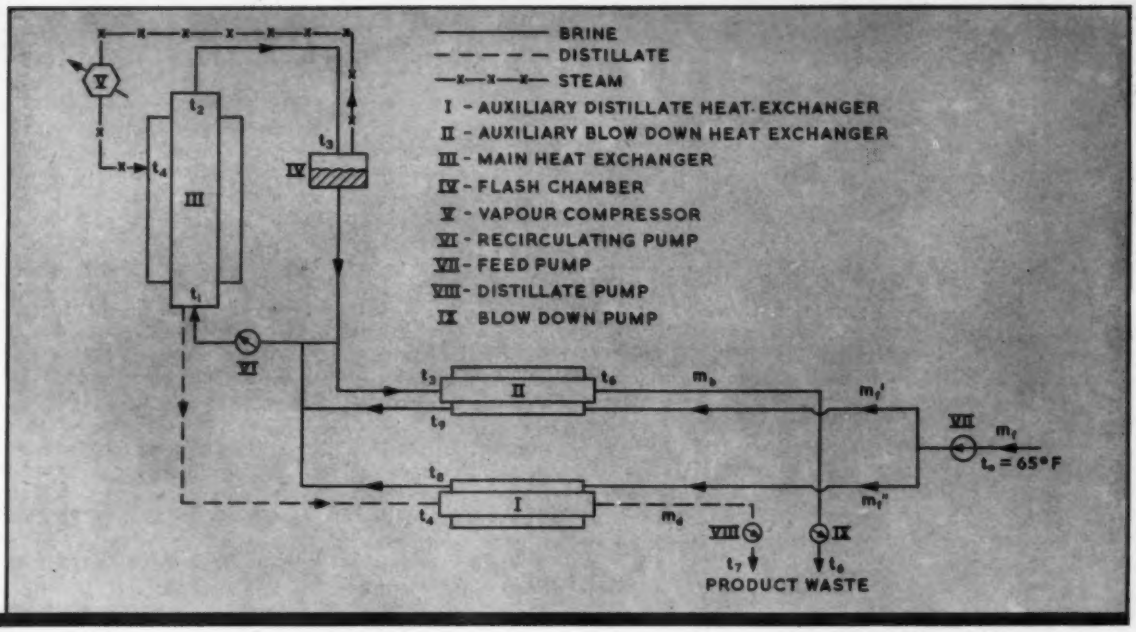

Fig. 2. Flow diagram of a forced-circulation vapour compression cycle.

A forced-circulation dropwise condensation vapour compression cycle for large-scale desalting

by A. M. ESHAYA, D.Eng., and B. F. DODGE, B.Sc.

thermal resistance of the tube wall of thickness x and thermal conductivity k. In heat exchangers suitable for marine service $\frac{x}{k}$ is usually less than 0.0001 and is relatively unimportant in determining the overall coefficient. The reciprocals of the film coefficients, on the other hand, are considerably higher (in the range of 0.001 to 0.005) and are quite important in determining the value of U. It is apparent from the nature of Equation (2) that a substantial increase in U can be obtained only if all the individual film coefficients are increased. If only one of the film coefficients is increased, its effect tends to be obscured by the other resistances which become controlling. Examination of the three individual film coefficients shows that it may be possible, by the application of special techniques, to increase them beyond the values currently associated with these coefficients in large heat exchangers.

Brine Film Coefficient

A large body of experimental evidence which confirms the validity of the DITTUS-BOELTER equation is in existence. This relationship, given for ready reference in Equation (3),

$$\left(\frac{hD}{k}\right) = 0.023\left(\frac{DV\rho}{\mu}\right)^{0.8}\left(\frac{C\mu}{k}\right)^{0.4} \quad \ldots . (3)$$

where h = film coefficient of heat transfer;
D = diameter of tubes;
k = thermal conductivity of fluid;
V = velocity of fluid in tubes;
ρ = density of fluid;
μ = viscosity of fluid; and
C = specific heat of fluid;

shows that the film coefficient for a fluid flowing inside tubes is proportional to the 0.8 power of the velocity, V, all other factors being kept constant. In a natural-circulation heat exchanger the velocity V is about 2 ft/sec., resulting in brine film coefficients in the range of 500 to 800 Btu/hr °F ft². If one were to increase the velocity from 2 to 8 ft/sec. by making the heat exchanger a forced-circulation one, the film coefficient will be increased by a factor of three. This increase is obtained at the expense of increased pressure drop through the tubes, and therefore should be balanced against the cost of the energy which needs to be expended by the recirculation pump in order to overcome this increased pressure drop. The fact that forced-circulation evaporators are very common in large-scale applications shows that it is possible by this technique to improve the heat-transfer rates to an extent which more than compensates for the additional pumping energy required.

Steam Side Coefficient

When steam condenses on very clean surfaces of metals usually used for the construction of heat exchangers, such as steel, copper, Admiralty, Cu-Ni alloys, etc., it condenses in the form of a uniform film which covers the metal surface completely. The theory of this type

of condensation was developed first by NUSSELT.[2] Experimental work has shown that while the NUSSELT theory is generally satisfactory in assigning the correct roles to the various factors and in predicting trends, the values of the condensate film coefficients calculated from it are from 10 to 30% lower than the experimentally measured ones. Turbulence of the film is usually considered responsible for the discrepancy, since the NUSSELT theory assumes streamline flow of condensate. The important thing to note is that, when film condensation occurs, the transfer of heat from steam to brine takes place across the resistance of a relatively sluggish film of liquid. As a consequence of this, the condensing film coefficients are only of the order of 800 to 1000 Btu/hr °F ft².

If the metal surface is contaminated by a hydrophobic layer of some impurity, the surface tension relationships among metal surface, liquid condensate and steam (usually expressed as a "spreading coefficient", which is a linear function of the metal-liquid, metal-gas and gas-liquid interfacial tensions) are so altered as to cause non-wetting of the metal by the condensate. In the place of a continuous film the condensing steam forms small drops which roll off the surface, exposing constantly new metal surface to the steam. This type of condensation is known as "dropwise" for obvious reasons. Early experimental work by SCHMIDT, SCHURIG and SELLSCHOPP[3] showed that condensation coefficients of 6000 to 8000 Btu/hr °F ft² were possible with this type of condensation. NAGLE, BUYS, BLENDERMAN and DREW[4] used oleic acid to promote dropwise condensation on a chromium-plated copper tube and measured coefficients of about 14,000 Btu/hr °F ft². FITZPATRICK, BAUM and MCADAMS[5] measured coefficients of 6800 to 16,900 Btu/hr °F ft² on copper surfaces with benzyl mercaptan as a promoter. Similar experiments by GNAM[6] and by SHEA and KRASE[7] point to coefficients of about 15,000 Btu/hr °F ft².

The action of promoters of dropwise condensation is understood quite well.[8, 9, 10, 11] Substances which promote dropwise condensation contain a hydrophobic functional group which is oriented toward the steam and away from the metal surface on which the promoter usually forms a mono-molecular layer. The presence of this layer alters the interfacial tensions between the three phases in such a way as to make the contact angle between liquid and solid greater than 90°F, i.e., brings about non-wetting of the metal by the condensate.

In considering the application of dropwise condensation to large-scale equipment one is faced with several serious problems. The first of these is how to maintain dropwise condensation for sufficient periods of time to make the scheme attractive industrially. Many promoters, while quite good in bringing about dropwise condensation, are washed away by the condensate too quickly to be of any industrial value. By incorporating in the promoter molecule a functional group which has special affinity for the metal, BLACKMAN and co-workers have been able to maintain dropwise condensation for more than 3500 hr. For copper and Cu alloy surfaces molecules containing Se or S show promise from the point of view of durability on a heat-exchange surface.[9, 10, 11]

The method of application of the promoter appears to be important. Direct application by dipping or brushing the promoter on the tubes has been used successfully, but is obviously not practical for industrial purposes. Introduction of the promoter in the steam, either in its pure form or as a solution or emulsion, has been tried with varying degrees of success.[13, 14, 15, 16]

The high rates of heat transfer associated with dropwise condensation may result in some cases in the complete flooding of certain parts of the heat exchange surface and thus offset markedly the advantages obtained by the dropwise condensation in the non-flooded part of the exchanger. This brings about certain questions as to the effect of the angle of inclination of the surface and general geometrical factors.[13, 14]

The effect of vapour velocity due to its condensate sweeping action, of the presence of non-condensable gases, as well as the influence of the pressure and temperature of the condensing steam have been studied in small-scale laboratory equipments,[14] but much additional work is needed to ascertain the role of these variables in full-size heat exchangers.

The application of dropwise condensation to the specific problem of sea water distillation has been studied by BLISS[16] in a single-tube heat exchanger. Condensate film coefficients of about 9000 Btu/hr °F ft² were obtained when dropwise condensation was obtained by injecting lard oil in the steam. BRUNT and MINKEN[12] experimented with a pilot-plant evaporator of the submerged-coil type and succeeded in increasing the overall heat-transfer coefficient from 900 to 2980 Btu/hr °F ft². In a larger scale experiment the same authors report an increase in capacity of an evaporator from 13 tons per day to 19.5 tons per day by the use of dropwise promoters.[12] A similar experiment on an even larger scale has been carried out in brine concentrating evaporators over a period of more than one year. The addition of promoters which appeared satisfactory on single-tube exchangers of an experimental assembly did not function at all in the full-scale evaporators.[15] In these trials the heat exchanger tubes were of Admiralty metal coated with a thin layer of lead and the promoting agent was Permacol (octadecylamine) injected in the steam as a 14% emulsion at a rate of 5 to 15 ppm pure Permacol to steam. A number of plausible explanations for the failure to produce dropwise condensation in these tests is possible; however, a logical conclusion from these experiments is that considerable work on industrial-scale equipment is needed before dropwise condensation can become an established industrial technique.

Scale Resistance to Heat Transfer

The term $\frac{1}{h_s}$ in Equation (2) introduces the resistance to heat transfer due to the accumulation of scale on the heat exchange surface. The factors affecting scale formation have been discussed elsewhere and the importance of scale formation on the economics of sea water desalination stressed.[1] Numerous methods for retarding scale formation are available. The more important of these are *p*H control (for $CaCO_3$ and $Mg(OH)_2$ scale); contact stabilisation which may be either external, in which case brine is circulated through a packed bed of solids, or internal, in which the solids are injected in the evaporator to act as precipitation centres; and treatments which modify the physical nature of the scale exemplified by the use of ethylene diamine tetra-acetic acid.[17, 18] In considering any scale-prevention method, however, it is important to bear in mind that the economics of large-scale sea water demineralisation probably does not permit an expenditure of more than 2-3 cents per 1000 gal. of product for this purpose.

Considering again Equation (2), it is seen that an increase of h_b and h_s is hardly worth while unless one were able to increase h_f proportionately. Thus, if one were to increase h_b from 800 to 2500 Btu/hr °F ft² by quadrupling the velocity, increase h_s from 1000 to 10,000 Btu/hr °F ft² by promoting successfully dropwise condensation, the overall coefficient would be increased only by a factor of 2 if h_f remains at an average value of 1000 Btu/hr °F ft². If now one is successful in increasing this coefficient to about 5000 Btu/hr °F ft², the overall coefficient will be increased to about 1250 Btu/hr °F ft²;

i.e., by a factor somewhat greater than 4 from the original overall coefficient. Present indications[20] are that overall heat-transfer coefficients of at least this magnitude are needed in order to arrive at product costs which approach those acceptable for the large-scale industrial utilisation of sea water.

In addition to the methods for retarding scale formation already mentioned, it may be possible to decrease the severity of this problem by incorporating the following four features in an evaporator:

(a) Forced circulation of the brine. There is some experimental evidence that high velocities of the brine in the tubes may retard scale formation. BLISS[16] has conducted tests with both synthetic and natural sea water for a period of 761 hr with brine velocities of 12 ft/sec. The average scale coefficient during this run was 5300 Btu/hr °F ft², i.e., more than five times greater than the value of 1000 usually associated with such a coefficient. KIRSCHBAUM and WACHENDORF[21] report less scaling by hard city water in forced-circulation heat exchangers as compared to natural-circulation units. Experience with forced-circulation evaporators in the chemical industry supports the view that high velocity is conducive to lower rates of scale formation.

(b) Evaporation at low temperatures. It is a well-established fact that the rate of scale formation is greatly decreased as the temperature of evaporation is lowered. This is due to the increased solubility of the scale-forming compounds at lower temperatures[22] as well as to the effect of temperature on rates of precipitation and carbon dioxide evolution.[23, 24, 25] It is reasonable to expect that distillation of sea water under reduced pressure, so that the temperature does not exceed 150°F, would result in very low rates of scaling.

(c) No boiling in the tubes. By avoiding the formation of vapour in the tubes of the heat exchanger, one eliminates regions of high concentration of salts within the heat exchanger and this, in turn, results in decreased rates of scale formation.

(d) Low distillate-to-waste ratios. By rejecting a waste which is not too concentrated, one may expect to find less scale formed per unit time on the heat exchanger. However, since dilute waste means a large ratio of feed to distillate, which in turn means the introduction of large quantities of "potential" scale in the exchanger, an optimum concentration factor of close to 2 seems to exist as far as scale prevention is concerned.[26]

Forced-circulation Vapour Compression Cycle

The application of the above ideas relative to the increase of the overall heat-transfer coefficient, U, by increasing h_b (through forced circulation), h_s (through dropwise condensation) and h_f (through low-temperature evaporation, forced circulation, use of a separate flash chamber, and low concentration factors) was proposed first by BLISS[16] and by the present authors.[19] The essential features of the cycle are shown in Fig. 2. Sea water enters the plant at 65°F and is heated up by the outgoing waste and distillate streams in auxiliary heat exchangers I and II. The feed stream then enters the main heat exchanger, III, and flows through the tubes at velocities of about 8 ft/sec. In its passage through the tubes, the feed is heated up by the steam condensing on the shell side in dropwise fashion. No boiling occurs in the tubes. After leaving the main heat exchanger the brine enters a flash chamber which is maintained at a pressure somewhat lower than the saturation pressure corresponding to the temperature of the entering brine. This causes a small fraction of the brine to evaporate. The vapour thus produced goes to compressor V, where its pressure is raised so that it can condense on the shell side of the main heat exchanger giving up its latent heat to the brine in the tubes. The liquid from the flash chamber is recirculated through the main heat exchanger by pump VI after a waste stream adequate to maintain the concentration in the heat exchanger at a predetermined value is withdrawn.

From the economic point of view, the important variables in the cycle are brine velocity, temperature approaches in the main heat exchanger, fraction of brine flashed per pass, and temperature of evaporation. A systematic study of these variables has been made by the authors[20] and the more important conclusions may be summarised as follows:

(1) *Brine velocity in tubes.* Higher velocities are, in general, identified with higher heat-transfer coefficients on the brine side (Equation (2)) which, in turn, lead to savings either in the total heat transfer area required or the necessary work of compression. Also, higher velocities may be conducive to diminished scaling and therefore to fewer costly shut-downs. On the other hand, increased frictional losses due to higher velocities increase pumping costs both energy-wise and through the need for larger and more expensive pumps and motors. The results of BLISS[16] lead to the belief that the optimum velocity is somewhere between 6 and 12 ft/sec. The more detailed analysis by the present authors shows that for energy and equipment costs now prevalent in the United States, the optimum brine velocity is in the range of 7.0 to 8.5 ft/sec. The optimum brine velocity turns out to be independent of plant capacity (in the range of 10^5 to 10^7 gpd), of temperature of evaporation (in the range of 160 to 212°F), of the fraction evaporated in the flash chamber, and of the temperature difference in the main heat exchanger.

(2) *Temperature approaches in the main heat exchanger.* The temperature differences in the main heat exchanger are related, for a given heat-transfer coefficient, to the total heat-transfer area required and to the temperature (or pressure) of the condensing steam, i.e., to both fixed charges and energy costs of the cycle. Depending on the exact value of the overall heat-transfer coefficient, the optimum temperature difference in the main heat exchanger varies from 4.5 to 5.5°F. By comparison, with current condenser and evaporator practice this is a small temperature difference, made necessary by the high cost of electrical energy needed to drive the compressor.

(3) *Fraction of brine flashed.* The value of the flashing fraction fixes the required temperature rise of the brine, which, in turn, affects either the necessary vapour temperature or the heat-transfer area of the exchanger. Furthermore, since the flashing fraction determines the quantity of product obtained per pass through the still. it affects the energy requirements and the size of the circulation pump. For lowest product cost, the flashing fraction varies from 0.0036 at an evaporation temperature of 160°F to 0.0040 when the evaporation temperature is 212°F.

(4) *Temperature of evaporation.* Operation of the main heat exchanger at a temperature of 160°F leads to increased cost of product, as compared with operation at 212°F, because of the higher first cost of a compressor needed to handle the large volumes of steam at low pressures. It appears desirable, therefore, to operate at as high a temperature as consistent with scaling considerations.

At the optimum combination of the above variables the product cost is estimated at $0.70 per 1000 gal. in a 10,000,000-gpd plant which can be built for $16,000,000. These costs are still too high to permit the large-scale utilisation of sea water for agricultural and most industrial uses; they are, however, lower by a factor of at least 2 than costs shown in present sea water demineralisation plants. In general while the specific cycle presented and

discussed in this paper appears especially attractive in the light of present knowledge, dropwise condensation could be used at considerable advantage in other distillation schemes such as multiple-effect evaporation or low-temperature flash systems. It should be stressed, however that the calculations which have led to the above figures are based on the assumption that dropwise condensation may be maintained in large-scale heat exchangers without recourse to costly materials and techniques. Laboratory experiments support the view that this can be achieved; however, much additional work is needed to establish this point.

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Scottish Industry on the Move

Archibald Low & Sons' Pioneer Factory Overspill Plan

MR. J. B. FAIRSERVICE, J.P., Provost of Kirkintilloch, at a ceremony attended by many civic dignitaries and representatives of Scottish industry declared the new factory premises of Archibald Low & Sons Ltd. officially open on September 15. This is the first new factory to be erected under the huge and costly redevelopment operation known as the "Glasgow Overspill Plan".

Briefly, this plan aims to rebuild entire sections of the city's dwellings on a new, wide-vista basis. This problem of rehousing the population gives rise to a further problem: that of resiting industry in the new overspill areas. Archibald Low & Sons (first formed in 1853) are one of the pioneers in this vast scheme, having moved from their former premises in the Partick area of Glasgow to a new factory at Kilsyth Road, in Kirkintilloch.

The new factory is situated on an 8¼-acre site to the north-west of the town—the cost of building having been financed by Steel & Co. Ltd., parent company of the Steel Group of which Archibald Low & Sons Ltd. are members. The old factory premises in Partick have been sold to Glasgow Corporation for redevelopment.

Designed for Expansion

Construction of the new factory began in December, 1958, and in a little over nine months all the buildings were completed and full production started. The factory itself is a three-bay, single-storied, steel-frame building covering approximately 40,000 sq. ft. which, in an area of 8¼ acres, leaves ample room for expansion. Design of the factory, too, has taken into account the probability of future expansion and will facilitate the erection of further bays and a second-storey office block. The sheeting of the factory is of sandwich construction in accordance with the requirements of the Thermal Insulation (Industrial Buildings) Act, 1957, and all the operations of the factory have been planned to meet the requirements of the Clean Air Act. Heating of the premises is provided by means of oil-fired boilers to underfloor hot-water heating coils. All the factory services: electricity, gas, water, compressed air, liquid oxygen and boiler-house have been planned to permit expansion when required.

In recent years the company has undertaken the supply and erection of fabricated pipework for the chemical and oil industries, civil engineering contracts, boiler-houses and heating installations. Sheet-metal work of all types, too, forms an important part of the company's business and they have the exclusive U.K. and European manufacturing rights for the "Alaflor" type of aluminium-alloy extruded gratings and treads. This product has gained rapid acceptance in industrial, marine and architectural circles.

The Alaflor extruded aluminium grid flooring and treads, although not a new product (the company first introduced it four years ago), is nevertheless finding increasing use in refineries where its strength and rigidity, combined with its high resistance to corrosive atmospheres and erosion, makes it a very attractive material for flooring and cat-walks. Economy is effected in steel supporting structures by using Alaflor, as it is self-supporting at the appropriate recommended span for each depth of section. Moreover, it is non-sparking and non-magnetic, two properties which make it an invaluable material for many structural situations in chemical plants.

One of the machines of especial interest in the fabrication shop of the new factory is a Hilger cold pipe-bending machine which is capable of manipulating pipes cold and unfilled from different materials up to 6 in. nominal bore. This machine, which was manufactured in Germany, is claimed to be the only one of its type in this country.

The advantages associated with the Koch Flexitray need little amplification here. Suffice to say that the major advances claimed are higher capacities for a given tower size, more efficient operating ranges and lower maintenance costs due to longer cleaning cycles. In design, the Flexitray has liftable caps of approximately 2 in. diameter which operate like check valves. These caps are limited in lift and guided by four posted, plate-stamped spiders which are clinched securely to the deck on 3 to 6-in. centres similar to bell-cap trays. Conventional downcomers of either chord or conduit type are employed. No gaskets are necessary and the Flexitray is not sensitive to out-of-level installation. Lack of sensitivity to out-of-level installation makes adjustable weirs unnecessary. Generally, two weights of caps are used on a tray. The two weights alternate in rows parallel to the outlet weir and serve to ensure vapour distribution at low vapour rates in spite of out-of-level installation. The company are to manufacture the Flexitray under licence from Koch International of America.

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CHEMICAL STONEWARE FOR CENTRIFUGAL PUMPS

An account of the manufacture of chemical stoneware pumps and their design features

by F. KELLY, A.M.I.Mech.E.

AS a material for resisting corrosion by acids and alkalis, chemical stoneware compares favourably with any metal or alloy. It can be used for any acid, except hydrofluoric, at any concentration with absolute freedom from corrosive attack, and is also an ideal material where liquids need to be free from metallic contamination.

It is widely used at present for open jars, vessels and piping for acid storage and distribution, and for such tower packings as Raschig ring or Berl saddles. In addition, the use of stoneware valves for corrosive liquors is extending. The correct design of such valves takes into account the low ultimate but high compressive strength and rigidity of stoneware, and, where armouring or metal reinforcing is used, the difference in thermal expansion between metal and ceramic.

Modern Manufacturing Processes for Chemical Stoneware

Modern chemical stoneware is compounded from several clays of known physical technical characteristics, and regular tests are made to ensure continuity of product. The clays normally used are: (a) ball clays and (b) china clays. In each case, particularly with ball clays, it is standard practice to use three or four clays. This is done partly to obtain a suitable blend of qualities and also that variation in any one clay will not produce too severe an overall effect. Clays are naturally occurring substances, and variations, often undetectable, occur in the clay bed. Ball clays are used more or less as dug and selected, but china clays are washed during mining and are more consistent in quality. The proportions in which ball and china

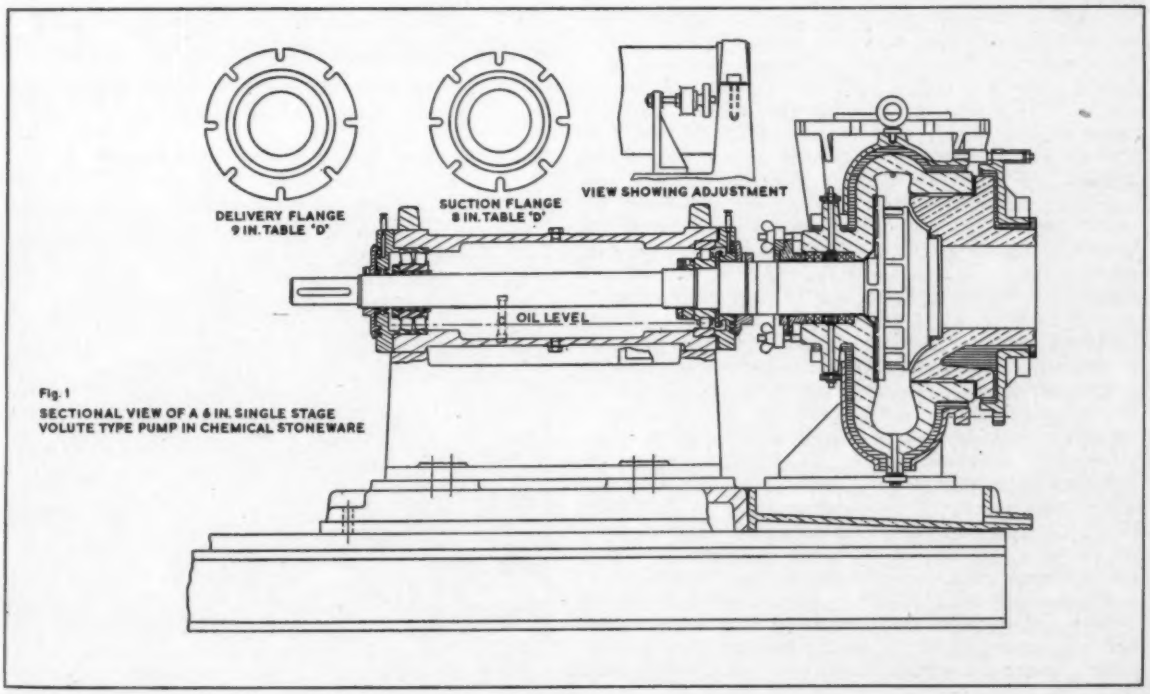

Fig. 1
SECTIONAL VIEW OF A 6 IN. SINGLE STAGE VOLUTE TYPE PUMP IN CHEMICAL STONEWARE

clays are used are determined by the eventual application of the finished article and also by the forming method to be used. The characteristics of these clays are:

(a) *Ball Clays.* These are of very fine particle size and so have high plasticity and very high dry strength. This makes them useful for extrusion or turning in the dried state where strength is obviously necessary. The fine particle size, on the other hand, tends to clog a plastic mould and also forms a thin, dense clay lining on the mould, so inhibiting further casting. Ball clays, due to fine particle size again, have high drying shrinkage and, if used on their own, would give trouble from cracking in drying. Because of the fine structure and presence of certain impurities which are difficult to isolate and determine, but which tend to act as fluxes, ball clays fire up to good verification and reasonably high strength but, again, with rather high firing shrinkage. So-called stoneware clays are essentially ball clays.

(b) *China Clays.* These are of considerably coarser particles and have much less plasticity. They generally contain less impurities, partially due to natural formation, but also due to the method of mining and washing. They have low dry strength and are not suitable for plastic forming methods. They are suitable for casting because the coarser particle size reduces the tendency to clog the plaster mould. Firing, however, through the coarser structure and lack of natural fluxes, produces a weak, porous material. Hence both types of clay must be properly blended in order to obtain the best results. This blending is a matter for individual experience and is one aspect of the potter's craft.

The constituent clays are pulverised as required and mixed with water into a slip to which is added the non-plastic ingredient of the mix. These non-plastics are usually quartz in suitable form, calcined alumina and proprietary calcines designed to produce the desired characteristic in the fired body. Also the flux is added at this stage which is usually a good-quality felspar. The particle size of these ingredients is of considerable importance if articles of consistent quality are to be produced and regular particle size analysis must be made. After very thorough mixing the slip is filter-pressed and the filter cakes are stored and aged before final processing. If the compounded clay body is to be shaped by a plastic forming process, the filter cakes are passed through an extruding mixer, at which time the water content is adjusted to the correct percentage (15-20%). If forming is done by casting, the press cakes are mixed with water containing an electrolyte to produce a slip of cream-like consistency.

Casting slips usually contain about 25% water and vary in weight between 34 and 36 oz. per pint. The electrolytes for deflocculating the clay are sodium silicate and sodium carbonate, either singly or mixed, depending on the characteristics of the clays being used. The amount varies very widely, depending on the proportion of clays, the percentage of non-plastics in the mix and thickness of the piece being cast. Normally the figure lies between 0.25% and 0.75% of dry weight of the mix.

The application of heat to the compounded body results first in the evaporation of the mechanically-held water. As the temperature is raised further, in an oxidising atmosphere any carbonaceous impurities are burned out. At temperatures around 600°C the clay substance breaks down and the chemically combined water, present in the raw clay, is given off. As the temperature increases, usually above 1100°C, the fluxes begin to melt, diffusing through the pores of the body and reacting with the other components, taking some into partial solution. This process of vitrification continues for a period determined by the maximum temperature required and duration of soaking cycle, the raw materials used, and the characteristics

Fig. 2. The working case mould for casting the parts of a chemical stoneware pump in process of manufacture.

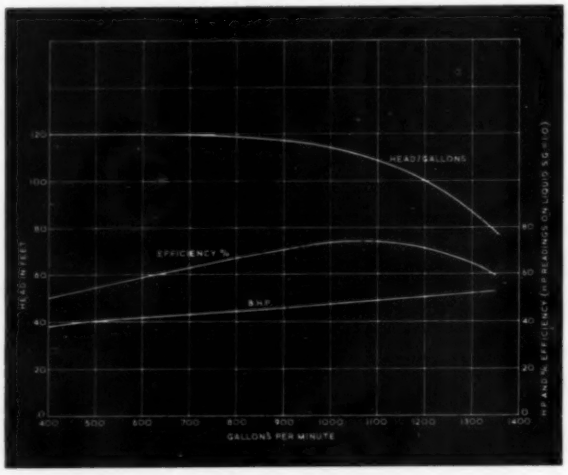

Fig. 3. Typical performance curve for a pump of the kind shown in Fig. 1.

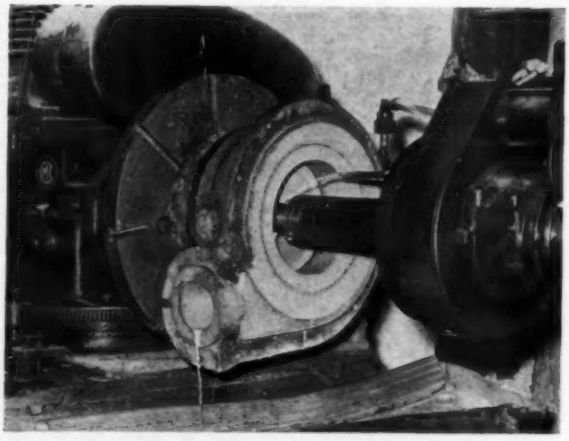

Fig. 4. The machining of the back face of the body of a chemical stoneware pump.

required in the finished product.

Experience plays a large part in the selection of firing cycles. A properly matured stoneware body is one in which there has been a selective and partial fusion of the body constituents. The viscous glass formed by the flux, commonly felspar, at elevated temperatures completely fills the pores of the body, the surface tension of the molten glass helping it to diffuse throughout the pore system, and at the same time tending to draw together the more refractory particles, so producing an overall shrinkage of the piece. The molten glass also reacts with the refractory particles of the clay, quartz and alumina, tending to the formation of aluminium silicate crystals, which contribute considerably to the mechanical strength of the cooled body. Other complex reactions and sintering take place during firing, but the action of the flux predominates. Peak temperatures for stoneware bodies normally lie in the range of 1200 to 1300°C and rates of temperature rise vary from between 10 and 50°C per hour, depending on the size, thickness and geometry of the piece. Too high a peak temperature or a very rapid temperature rise may produce glass too rapidly or a glass which is too fluid, so causing the piece to sag or warp or to contract at a rate exceeding the temporary strength of the body which would result in cracking. Too low a peak temperature or too short a cycle would result in curtailment of the desired reactions, so giving a weak and underfired body. The usual procedure is to reach a peak temperature at a rate found suitable for the type of body used and the pieces being fired, and then to hold this temperature for a period to enable the desired reaction to proceed. Periodic checks may be made on the process by withdrawing fired samples from the kiln for visual inspection and measurement of shrinkage. Clearly, temperature alone does not indicate a satisfactory firing cycle.

The compressive strength of good quality stoneware is similar to that of cast iron. However, in the case of brittle materials, the usual factor of strength quoted is the transverse bending strength or modulus of rupture, which in the case of good quality stoneware is in the region of 14,000 psi; and the ultimate tensile strength would be approximately 3000 psi. The judicious design and application of metal armouring and reinforcing does, however, permit ceramic materials to be safely used for highly mechanically stressed applications without in any way detracting from the excellent corrosion resistance of the ceramic.

General Design and Manufacturing of a Chemical Stoneware-lined Acid Pump

The sectional arrangement of a 6-in. stoneware pump reproduced in Fig. 1 represents sound practice in the use of heavy-section stoneware combined with efficient armouring. This pump has recently been designed to provide a reliable pump capable of handling large quantities of acid and acid effluents. It will raise 7 tons of acid per minute to 100 ft head and is fitted with a 75hp 1450-rpm motor on account of the high specific gravity of the acid being pumped. The hydraulic design of the pump is, of course, the conventional single-stage volute type of pump with a typical performance curve typified by Fig. 3.

With metal pumps it is usual for impeller diameters to be reduced to give maximum efficiency figures at a specified duty point, but with the smaller sizes of stoneware pumps, due to machining difficulties of the impellers, this practice is not followed. The reason is that the machining of chemical stoneware is a tedious and expensive operation, requiring the use of diamond-impregnated wheels. Instead, specific duties are obtained by running the pump at intermediate speeds by a vee-belt drive. Alternatively, output is controlled by means of a valve on the delivery side in the case of a direct-coupled pump. This may result in a slight loss of efficiency, which is unimportant in view of the advantages of corrosion-free operation, ease of maintenance and replacement, and the fact that the pump can be used on any acid duty within the limits of its maximum hydraulic capacity with absolute freedom from corrosion. For large pumps, where power consumption is important, the impeller can be made smaller to fit specific duties. This is done by cutting back the impeller in the clay stage.

In the pump shown in Fig. 1 substantial bearings supporting the impeller are noteworthy. It is essential that bearing design and spacing should avoid any friction in the gland itself where the packing must not act as a bearing. With the impeller rigidly supported and normal running clearances in the gland, in service the gland should run almost dry through the effect of the radial vanes behind the impeller. These vanes maintain a liquid seal at the impeller periphery. By adjusting the pump body and impeller clearances to suit the characteristics of the installation, the gland is virtually leakproof in operation.

Manufacturing Processes

Modelling and Casting. The modelling process in the production of corundum chemical stoneware parts can be likened to the pattern making for metal castings, except that moulds are produced in plaster of Paris with shrinkage allowance of up to 12%. Modelling is a highly-skilled job in that the model of the completed components are hand-made from works drawings with the appropriate shrinkage allowances. From the models the master moulds are prepared of plaster of Paris similar to the patterns and core boxes used in metal casting processes. However, during the casting of production pieces, a proportion of water is absorbed in the mould itself before the piece is removed and dried so that, in continuous use, the moulds become saturated and require replacement. The master mould is not, therefore, used for normal production purposes, but is retained as a standard from which intermediate moulds known as Case moulds are made. Replacement working moulds are taken from these Case moulds. The manufacture of a working mould is illustrated in Fig. 2. During casting, the moulds are filled with casting slip much in the same way as metal is run into the foundry mould, except that the slip is put under pressure to assist casting.

Drying. Before firing, the pieces must be carefully dried. This is a difficult process, particularly where large pieces or very thick sections have to be treated. The safest and most effective method is to use drying chambers in which the humidity is maintained at a high level, so inhibiting drying until the top drying temperature is reached; thereafter the drier atmosphere is changed at an even rate and drying proceeds. This allows the drying and heating stresses to be taken independently, and the reduction in the viscosity of the water at the higher temperatures facilitates its diffusion through the fine pores of the clay. For very large pieces and where the batch-type drying necessary with humidity chambers is not practicable, the well-established method of hot floor drying is normally used. The pieces can then be muffled with cloth to slow down the drying rate.

Firing. With the proprietary industrial porcelain articles produced for specialised purposes, the modern tendency is to use relatively small gas-fired or high-temperature electrically-heated intermittent kilns. Close firing control is very necessary with certain of the special-purpose bodies where the vitrification and fusing temperatures are very close together and where slight overfiring would result in severe warpage of the piece, whereas underfiring by a small margin would give a mechanically weak and porous

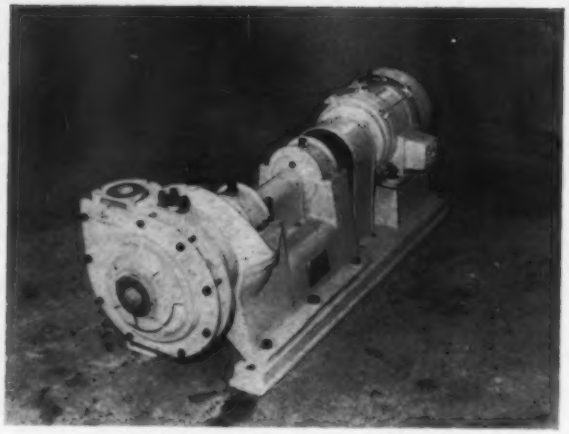

Fig. 5. Illustration of a completed chemical stoneware centrifugal pump.

article. High-temperature electric kilns giving excellent control of temperature and atmosphere are finding increasing application in the firing of these special-purpose bodies.

Assembly and Machining. The body and cover are afterwards assembled in the cast-iron armouring which has previously been machined to finished dimensions. In this process the corundum linings are set in the armour with acid-resisting cement. This is allowed to set hard again under controlled drying conditions, and after this treatment the components are ready for final machining of the linings. In the case of the impeller head, this is similarly fixed on to a mild-steel shaft and the cement injected to give a complete bond after the impeller head has been locked in position against a spring-loaded plunger by means of lock nuts on the main shaft. The accurate machining of the corundum parts to fine tolerances is carried out by high-speed grinding machines. Machining is done by location from previously machined surfaces of the armouring, to ensure dimensional interchangeability and drilling of the body flanges, etc., and is finally carried out from location on the bore of the machined linings As the corundum is extremely hard, it cannot be ground by ordinary carborundum wheels and it is therefore necessary to use special diamond-impregnated wheels of various sizes and shapes to produce the contours required in the finished components. Fig. 4 shows the machining of the back face of a pump body. In the machining of an impeller this component and shaft are set up between centres and accurately ground to finished dimensions to ensure complete concentricity of the impeller and the mild-steel shaft.

Final Assembly and Test. After inspection of individual components in the pump, assembly is a straightforward matter, as in the case of normal metal pumps. Each pump is tested for head and capacity on a testbed. Finally, it is carefully assembled on cast-iron bedplates with the necessary motor and suitably protected for delivery by fitting blanks over the connections. Fig. 5 shows a 2-in. pump capable of handling 100 gpm of acid against a head of 45 ft.

The chemical stoneware centrifugal pump offers a very satisfactory solution to the problem of handling corrosive fluids such as mixed acid, its sole limitation in this respect being its lesser resistance to hot caustic alkalis and hydrofluoric acid. Moreover, its ability to withstand abrasion—chemical stoneware is extremely hard, since its hardness number on the Moh scale is about 8—makes it a very suitable material of construction for pumps which have to handle abrasive slurries.

ACKNOWLEDGMENT

The author wishes to acknowledge the co-operation of L. A. Mitchell Ltd. for the drawings and sketches illustrated in this article.

C.B.M.P.E. Annual Dinner

SOME 1490 guests and members—among them His Excellency, Mr. Malik, the Ambassador for the Union of Soviet Socialist Republics in this country, and Mr. Edwin M. Martin, the Minister of Economic Affairs of the United States—attended the annual dinner of the Council of British Manufacturers of Petroleum Equipment, held on October 1, at Grosvener House, London.

The chairman, Mr. C. H. Thorne, in his speech of welcome, stated that the membership of the C.B.M.P.E. had now reached a total of 500 firms. Commenting on the formation of a totally-owned subsidiary—The British Oil Equipment Credits Ltd—known affectionately as B.O.E.C., the chairman announced that it had already signed one agreement with PEMEX, the Mexican Petroleum Co., for £3¼ million, and that this project alone might be increased to £7 million. "By the grape-vine," said the chairman, "we have heard of another large project in Latin America where, too, the Credits Co. may be able to assist. We also have projects under consideration in other parts of the world," he added.

Dr. James Burns, a board member and chief engineer of the North Thames Gas Board, in his reply to the chairman's address of welcome, underlined the very long connection between the oil and gas industries and spoke also of the future for both, especially on fuel matters. Regarding this, he said: "There is one important factor in which there is likely to be a change, and that is in the transportation of fuel. At the present time the major portion of our coal and oil raw materials in the gas industry are transported to the point of usage. The situation has now arrived when it is no longer economic to transport these materials overground, but rather to transport the products in the form of gas underground by pipeline. Thus with coal as a raw material it is likely that plants of the future will be placed on the coalfield with minimum transportation charges, with oil or oil products transported thereto by pipeline to produce a gas suitable for national distribution. At the great oil receiving centres of the country there will be set up plants both for base load and peak load purposes, using oil as a raw material, and again feeding into a countrywide distribution system.

"There does appear, therefore, at present price relationships to be a basis for useful collaboration between coal and oil to provide a fuel service on more economic lines than is possible today. On this basis the gas industry can look forward to continuing and increasing collaboration with the British Manufacturers of Petroleum Equipment."

Corrections: Scale up: Part I, October 1959, p. 530.

Equation (4) should have read

$$\varphi\left(\frac{hD}{k}, \frac{c_p D V \rho}{k}\right) = \text{constant}$$

and Equation (5) should have read

$$\varphi\left(\frac{hD}{k}, \frac{DV\rho}{\mu}, \frac{c_p \mu}{k}\right) = \text{constant}$$

Following Equation (6), Fouriers equation, Equation (IX) of the appendix (given in part II) is stated. The left hand term of this equation should read

$$c_p \rho \frac{\partial t}{\partial \theta}$$

681.128: 539.16

Fig. 1. A radioactive level gauge in use. The level of liquid CO_2 in the cylinder is being measured.

RADIOACTIVE LEVEL GAUGES

A description of instruments suitable for following or indicating varying liquid levels

by J. F. CAMERON* and E. W. PULSFORD†

LEVEL gauges employing radioactive sources and appropriate detectors‡ are finding application in a number of industries. The exact method of application varies,[1–10] but the method capable of the most diverse application depends on the absorption of gamma radiation by the material whose level it is desired to find.[1–7, 10] The absorption is measured by an appropriate detector. Three methods of achieving this are illustrated diagrammatically in Fig. 4. The basic components of such systems are: (a) a long-lived radioactive source emitting gamma radiation—cobalt-60 (half-life 5.3 years), cæsium-137 (30 years) and radium-226 (1600 years) are the ones most commonly employed; (b) a gamma-ray detector—this is usually a Geiger counter because of the simple associated electronic circuitry, but scintillation counters and ionisation chambers are occasionally employed; and (c) the electronic indicating and control unit.

The outstanding advantage of the gamma-ray method is that it can operate with the essential components mounted outside the vessel. Thus: (i) the apparatus can be installed without interrupting or disturbing the process or modifying the container in any way; (ii) as the components are not in contact with the contents, the method can be applied to sterile, corrosive, high or low temperature, viscous, abrasive or otherwise difficult materials; and (iii) servicing of the instrument and maintenance are made easier.

It should be noted, too, that the material itself is not made radioactive or changed in any way and the dimensions and thickness of the source containers can be made to eliminate radiation hazard to operating personnel.

The accuracy of the method is dependent on the relative change in detector output with a change in level, and this is determined by the dimensions of the container (but not the wall thickness) and the density of the contents. Because the thickness of the container walls is constant, the only effect they have on level measurements is to decrease by a constant factor the amount of radiation reaching the detector, and this can be allowed for by increasing or decreasing the activity of the source.

Advantages of Different Gamma-ray Methods

In the arrangement illustrated in Fig. 4a the source and detector are fixed at the same level on opposite sides of the container, and when the level of the material is such that it absorbs some of the radiation the detector output decreases. The relation between detector output and level is approximately that shown in Fig. 4b. With this fixed arrangement of source and detector, the range of levels which can be covered is very limited, but over this range it is very accurate. It is also ideal as an on-off indicator for manual or automatic level control.[1, 2, 5]

In order to increase this range with fixed source and detector, the displaced source and detector arrangement illustrated in Fig. 4c and the extended source and detector arrangement illustrated in Fig. 4e are used.[4, 6, 7] The approximate relation between detector output and level for these arrangements are indicated in Figs. 4d and 4f. The strip source and extended detector arrangement (Fig. 4f)

* Isotope Division, A.E.R.E., Harwell.
† Electronics Division, A.E.R.E., Harwell.
‡ Manufactured by Baldwin Instrument Co. Ltd., Dartford, Kent: Ekco Electronics Ltd., Southend-on-Sea, Essex; Isotope Developments Ltd., Aldermaston, Berks.

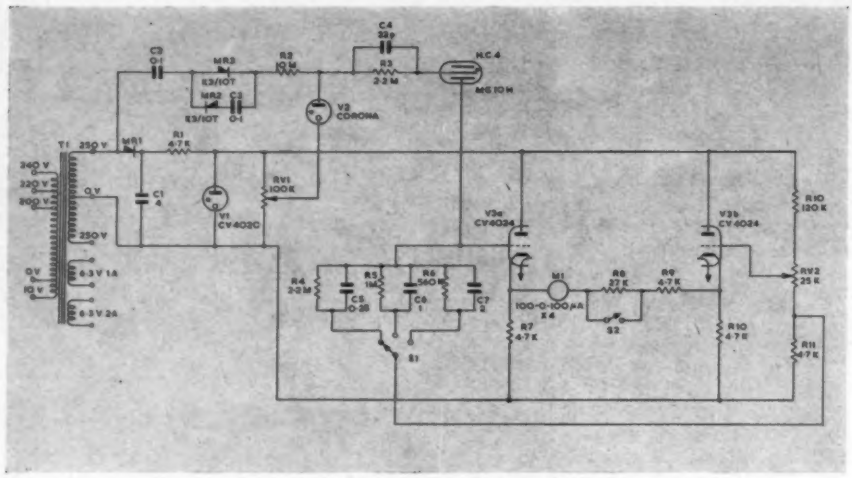

Fig. 2. Simple ratemeter circuit for level indication. In this circuit the Geiger pulses are fed to an R-C network and the mean voltage across this network is monitored by means of a balanced double triode. The E.H.T. on the Geiger is the sum of the voltage doubler output and the variable fraction of the 0-150-volt, neon-stabilised H.T. supply.

result in an approximately linear relation between detector output and level, but long sources are difficult to obtain and to shield, and long detectors are not readily available. The exponential output obtained with the displaced source and detector arrangement (Fig. 4c) results in a poor accuracy at one end of the level range and the range of levels is limited by practical source activities to about 3 or 4 ft of water or equivalent depths of other materials. In addition, the amount of absorption is a function of the density of the material and this restricts the latter method to constant density materials. An empirical calibration curve is essential with the above methods and this is often extremely inconvenient.

In order to obtain accurate measurements over long periods, a stable but complicated and relatively expensive indicating unit is required. Probably the best method of covering a wide range of levels is to move a horizontally aligned source and detector to find the level. This can be achieved manually, using a simple rigid mechanical link between source and detector for measurement on small containers, and a linked pulley or rack-and-pinion system on larger containers. A simple servo mechanism, energised by the distinct change in detector output as it passes the liquid level, can be used for automatic continuous indication. As the change in detector output obtained as the source-detector system passes the level is usually large, small changes in detector output can be tolerated without reducing the accuracy. This permits the use of inexpensive electronic circuits. The density of the medium is not important and calibration is not required.

Mobile Source-detector Systems

A simple circuit for achieving automatic continuous indication is shown in Fig. 2. The pulses from the Geiger counter are integrated in the RC tank circuit connected to the grid of a thyratron which is biased so that it is not conducting when the source and detector are below the level. One field and the armature of a split field motor are continuously energised and are so arranged that the source-detector system is driven upwards. When the level is passed, there is a significant increase in counting rate which causes the thyratron to conduct, with the result that the other field is energised at twice the current of the first and the source-detector arrangement is driven downwards. The counting rate returns to normal when the level is again passed and this allows the thyratron to be extinguished; the continuously energised field again takes over and drives the system upwards. This process continues indefinitely with the source-detector arrangement hunting over a small distance on either side of the level.

For continuous measurement of the level of water in an 8-in. O.D. 7-in. I.D. steel tube surrounded by 2 in. of asbestos lagging on a high-pressure, high-temperature water research loop, an 8-watt motor (Evershed & Vignoles Type FP30D/K10) drives the system shown in Fig. 5 after reduction of 2500:1 in a gearbox. The 20 Mc/s source of

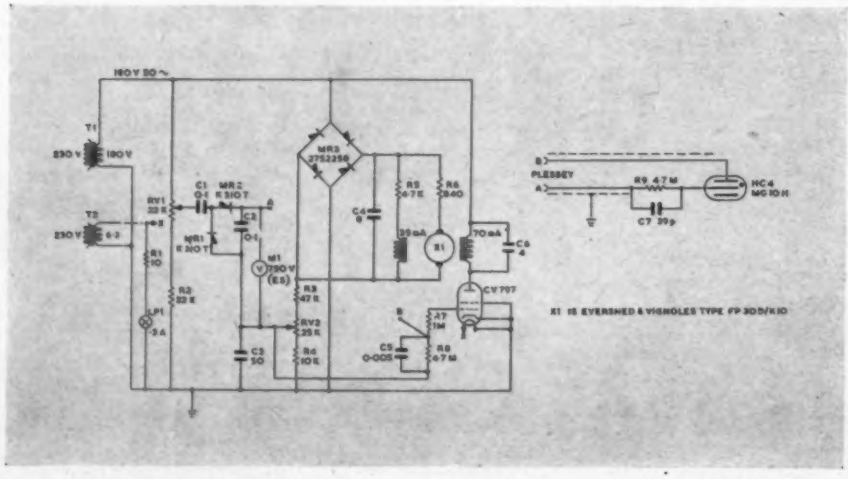

Fig. 3. Hunting level gauge circuit. The anode voltage of the thyratron in this circuit is supplied with a 180-volt R.M.S. supply. A full wave bridge rectifier across the transformer secondary winding supplies a steady current through the armature and one field winding. Negative bias for the thyratron is obtained from this bridge network and the potentiometer R_3, R_4, $RV2$. The counter E.H.T. is supplied by means of a simple voltage doubler circuit and can be accurately adjusted by means of $RV2$.

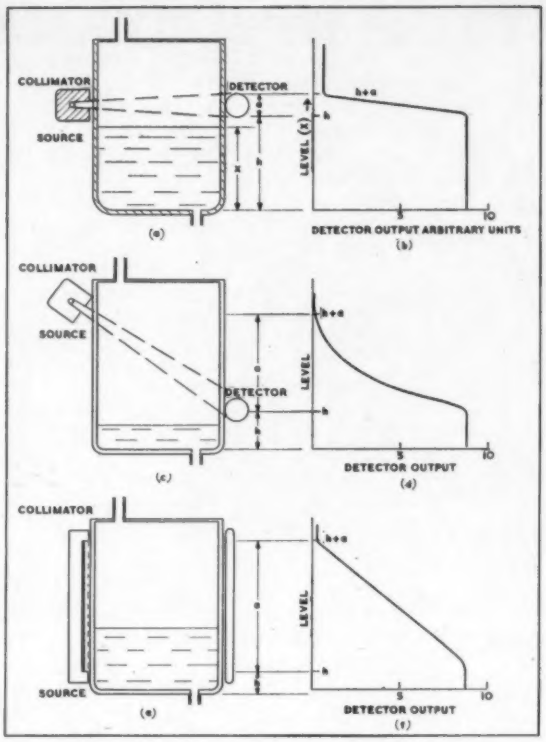

Fig. 4. Some source detector arrangements used in level gauging (schematic).

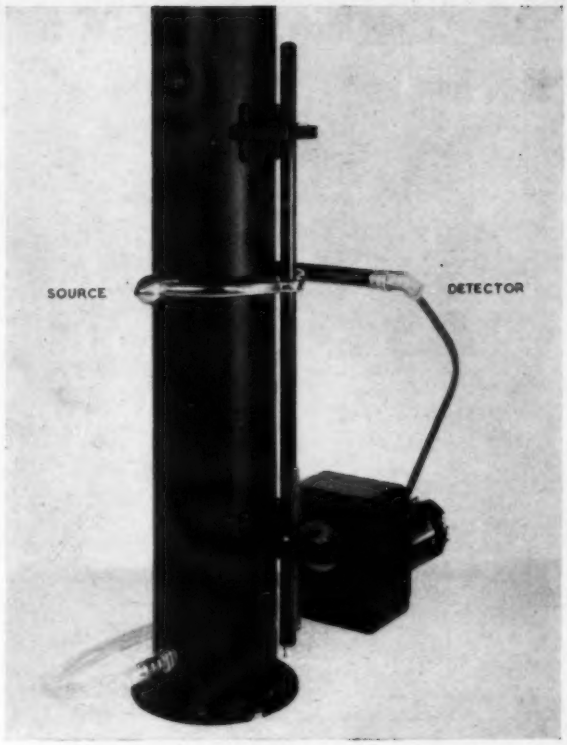

Fig. 5. A servo-operated level gauge showing detector and source.

cæsium-137 and the MG 10H Geiger counter are fixed to a rigid aluminium alloy frame which runs on two steel guide tubes and is driven by a pulley system. The moving portion weighs about 40 lb. including a 20-lb. counterweight. With this arrangement an accuracy of about ±1mm was obtained. The level can be indicated continuously either mechanically using a pointer or electrically by using a magslip.

An alternative electronic circuit is shown in Fig. 3. One instrument incorporating this circuit is used to determine the level of liquid CO_2 in high-pressure cylinders used in fire extinguishing equipment and is shown in Fig. 1. A 1-Mc/s source of cæsium-137 and a gamma Geiger counter (MG 10H; 20th Century Electronics) are fitted to the U-shaped arm. This arm is slipped over the cylinder and moved up and down to find the level. The counting rate is indicated on a meter mounted on the front of the small mains-operated unit, and the change in counting rate obtained on passing the level is readily apparent. This method is now preferred at Harwell to the former tedious process of weighing each cylinder. The technique can also be applied to other liquids or liquefied gases such as methane, oxygen and chlorine.

ACKNOWLEDGMENTS

The authors gratefully acknowledge the assistance received from T. V. Suttar, G. Fox, G. Brandon, J. C. Woodmore and P. Berry in developing the instruments described above.

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Polyether Foam in Full Production

ON plant originally designed for polyester production, Aeropreen Ltd. are now producing polyether foam by reacting a pre-polymer of a polypropylene glycol derivative with the catalysts and other foaming reagents in a mixing head. The engineering problem is said to be efficient mixing of a pre-polymer of 8000 cps viscosity with two other liquids of the viscosity of water. Perfect and speedy mixing are essential to produce a uniform product; the mix must be discharged uniformly on a paper-lined moving belt and with a minimum resistance to flow at the discharge point of the mixing head. Mixing takes 20hp for a yield of 4 tons per hour. Reagents are delivered into the mixing head by means of metering pumps; delivery on the pre-polymer line is controlled by means of an automatically controlled variable-speed gear.

The first stage of polymerisation is carried out in three one-ton jacketed resin kettles where the polyether resin is produced under a carbon dioxide "blanket" and is then pumped to storage tanks, where it is kept until required during a production run. It is mixed with the activator complex in the foaming head of the main plant only when required for a production run.

The resulting polyether foam, cured at 120°C, is claimed to cost 20 to 25% less than latex-based equivalents. Like earlier plastic foams, it can be washed, boiled. sterilised and is unaffected by sea water, detergents, disinfectants, urine, greases, oils, fuels, many acids, or damage to its surface and it does not suffer from oxidation.

REPORT ON THE SCOTTISH INDUSTRIES EXHIBITION, 1959

(Photo: Geo. Outram & Co. Ltd.)

Chemical engineering and chemical products occupied a prominent position at the largest trade fair held in Britain this year

AT approximately 10.50 a.m. on September 3, Her Royal Highness Princess Margaret declared open the Third Scottish Industries Exhibition, held in the Kelvin Hall, Glasgow, and claimed to be the biggest general trade fair held in Britain during 1959. Promoted by The Scottish Council (Development and Industry), an independent, non-political body directly representative of industry, Chambers of Commerce, etc., and whose main purpose is to promote the industrial and economic well-being of Scotland, the Exhibition was designed to show the traditional and modern skills, which, allied to new production techniques, have made Scottish craftsmanship famous the world over. To these renowned and typically Scottish industries there has, in recent years, been added a whole range of new science-based industries, such as petrochemicals, which, when it is considered that Scotland's percentage of university graduates in the applied sciences is the highest in the United Kingdom, is hardly a surprising addition to the Scottish industrial scene.

As an indication of the extent of Scotland's industrial upsurge, over 500 new factories, or extensions to existing ones, covering 15,000,000 sq. ft of floor space with a resultant increase in products manufactured, have been built since the last Exhibition was held in 1954. Even so, the 1954 Exhibition took place at a time when the Scottish economy, although on the upgrade, still gives real cause for concern. Its impact, therefore, could be a decisive factor in swinging the balance down on the side of a still busier time for Scottish industry, and that part of it devoted to chemical engineering in particular.

Chemical Manufacturers

Imperial Chemical Industries' stake in Scottish industry grows rapidly in size and importance. The company's Nobel, Dyestuffs and Pharmaceuticals Divisions, who shared a stand at the Scottish Industries Exhibition, all have large-scale plants in Scotland. Recently, another I.C.I. manufacturing group, the Plastics Division, announced plans to build a £2½-million plant at Dumfries for the manufacture of "Melinex" polyester film which is expected to be in production by the end of 1960.

A section of the Nobel Division's exhibit was devoted entirely to I.C.I. silicones—a versatile family of products which are daily finding new uses not only in industry but also in the home. Paints based on silicones protect such equipment as space heaters, metal chimneys and exhaust pipes at temperatures up to 600°C for long periods without deterioration. The effects of anti-stick and anti-foam silicone agents were also illustrated. Rollers and drums coated with I.C.I. silicones provide a stick-free surface. In heat-sealing equipment and in processing sticky materials silicone mould-release agents facilitate easy removal of articles moulded in natural rubber or plastic materials.

The Distillers Co.'s stand occupied over 1600 sq. ft and included two separate display areas. The main theme of the Industrial Group's exhibit was the development, in the past 10 years, of the great petroleum chemical works at Grangemouth, Stirlingshire, of British Hydrocarbon Chemicals Ltd., in which D.C.L. and The British Petroleum Co. Ltd. are jointly interested. The central feature was a model of the whole of the Grangemouth site, on a scale of 1:500, housed in a globe some 10 ft in diameter and visible through a series of portholes. The globe was floodlit from below the raised floor of the section, and was silhouetted against the illuminated back wall of the stand, on which were mounted the remaining displays of colour transparencies and other exhibits. On the scale concerned, little technical information could, of course, be deduced from the model, the purpose of which was primarily to show the British Hydrocarbon Chemicals' plants as forming an efficiently laid-out and busy works impressive in size and complexity and typical of the best in modern chemical plant design. In fact, they have become the nucleus around which much of D.C.L. post-war industrial expansion has been centred.

The sectional displays dealt in sequence with:

(a) the general scheme of chemical processes at Grangemouth;

(b) the new D.C.L. process for making phenol, as typical of the technical contribution which D.C.L. has made to the Grangemouth partnership;

(c) the production, properties and applications of "Rigidex", the new polyethylene now coming into production at Grangemouth;

(d) the production by the D.C.L. Plastics Group of polystyrene, phenol-based resins, synthetic rubbers and other plastics based on Grangemouth chemicals;
(e) the use of Grangemouth products for the production of solvents, plasticisers and other industrial chemicals by the D.C.L. Chemical Division; and
(f) the applications of carbon dioxide in Scottish nuclear power stations, welding and foundry work.

A separate set of displays showed the industrial development of fermentation processes, which led D.C.L. to the manufacture of yeast and malt extract and, more recently, to the production of penicillin, streptomycin and other antibiotics and biochemicals. Striking features of the displays were two mural backgrounds, one a 32-ft-long enlargement of a photograph showing the Grangemouth works at night and the other a montage of enlarged yeast cells, penicillium mould colonies and plastics molecules, symbolising the main activities of the D.C.L. Industrial Group.

The British Petroleum Co. Ltd. had on view a model of their Grangemouth refinery which is situated on the Firth of Forth and is owned and operated by B.P., whose products are marketed under the internationally known B.P. house-mark. Grangemouth Refinery was opened in 1924 and until the Second World War it processed about 400,000 tons of crude oil a year. Because of lack of supplies during the war, it had to close down and only recommenced operations in 1946. The growing post-war demand for oil products made it necessary for the refinery to be substantially enlarged and an expansion project, involving the erection of new plant and the remodelling of existing units, began in 1949. This project was completed in 1954 and raised the refinery's capacity to 2,200,000 tons a year. Further expansion, completed in 1959, has raised the refinery's capacity to 3,200,000 tons a year. Among the refinery's products is feedstock for petroleum chemical plants.

The most important units in the refinery are the distillation units, through which all the crude oil must pass. In the units the incoming crude oil is first passed in tubes through a furnace where it is heated to about 650°F and then fed through a series of distillation towers. In the main distillation tower benzene, naphtha, kerosene, light gas oil, heavy gas oil and residual fuel oil are separated at various levels in descending order.

Residual oil from the distillation units is further distilled in the vacuum distillation unit to produce a feedstock for the catalytic cracker which converts feedstock from the vacuum unit into high-grade lighter products. Two separate liquid gas streams from the catalytic cracker are fed into the catalytic polymerisation unit after being purified by the removal of hydrogen sulphide and other sulphur compounds. One stream is treated in a butane polymer unit and converted into high octane polymer, an important component for raising the quality of motor spirit. The other stream is converted into tetramer and piped to the plant of British Hydrocarbon Chemicals Ltd., referred to above, where it is used in the manufacture of chemicals.

British Hydrocarbon Chemicals also have a major interest in two subsidiaries—**Forth Chemicals** and **Grange Chemicals**—each with a plant at Grangemouth. Forth Chemicals—formed in 1950 jointly with **Monsanto Chemicals**—produce monomeric styrene, a chemical intermediate for making the plastic polystyrene, while Grange Chemicals—formed in 1955 in association with **Oronite Chemical Co. of California** (a subsidiary of **Standard Oil Co. of California**)—make detergent alkylate (dodecyl benzene), an intermediate for manufacturing high-grade detergents. In addition, **Gemec Ltd.**, a subsidiary of **Union Carbide Co.**, has plant for the production of polyethylene from ethylene supplied by British Hydrocarbon Chemicals.

Heavy Engineering

The Babcock & Wilcox exhibit at the Exhibition included several "firsts" in the field of atomic power generation, nuclear ship-propulsion and the utilisation of small coal for industrial boiler-firing.

Dominating the Babcock stand was a giant 20-ft-long transparency in full colour, exhibited for the first time in Britain, which showed dramatically the building of the world's largest atomic power station at Hinkley Point by the **English Electric, Babcock & Wilcox, Taylor Woodrow Atomic Power Group**.

With Britain's problem of excess small-coal stocks looming large on the industrial horizon, special importance attached to the exhibit of a model showing a new method of firing industrial boilers efficiently and smokelessly with small coal or even with coke breeze dust, using the Babcock-Ignafluid stoker, of which Britain's first installation will be at the Westfield, Fife, plant of the **S.G.B.**

Examples of their Long Cone Cyclone developed specifically to give high dust-collecting efficiencies with moderate pressure loss were shown on the **James Howden & Co. Ltd.** stand. The Cyclone is manufactured in a range of sizes, in single or twin units, which can be banked with similar units and operated in parallel to suit required duties. Typical extraction efficiencies claimed for these units are in the order of 90% on fine dust from pulverised-fuel boilers and about 96% on coarser dusts. The collector, it is claimed, has one significant advantage in that it is not prone to chokage troubles as there are no vanes and the minimum bore is 6 in.

J.H. have recently concluded an agreement with **Lurgi Apparatebau-Gesellschaft M.B.H.** for the manufacture under licence of Lurgi electro-precipitators under the trade name of **Howden-Lurgi**. These will be available for a wide range of applications.

The precipitator designs are based on many years of practical experience in these fields and provide high extraction efficiencies allied with low power consumption and low pressure drop. The detailed designs differ according to the application and the specified performance and include parallel plate arrangements, incorporating one, two or more precipitator zones in series (as required) for horizontal or vertical gas flows, and vertical tubular units, with centrally disposed wire or other suitable discharge electrodes in each case. Casings are of fabricated mild steel construction, suitably lagged and weather protected where necessary, or may be of reinforced concrete. The former leads to considerably reduced foundation loads.

In operation, a high uni-directional voltage is applied to the discharge electrodes and sets up a corona discharge from their ionising edges, causing a stream of electrons and negative gas ions to travel continuously across the gas stream to the collecting plate electrodes. The gas-borne dust particles passing between the collecting plates and the discharge wires become electrically charged by attachment of these negative charges and migrate, under the influence of the electric field, to the surface of the collecting electrodes on which they are deposited. When the collecting electrodes are rapped the dust slides down, in a zone shielded from main gas flows into hoppers.

Appropriate alternative designs of collecting and discharge electrodes are available to provide the most efficient operation for different applications and effective electrode rapping gear is fitted as necessary.

On the **G. & J. Weir Ltd.** stand was a huge colour transparency which depicted the 2,000,000-gallon-a-day Weir plant for producing fresh water from the sea, now being built at Kuwait, in the Persian Gulf (see p. 596). Weirs are known widely for their plant for the large-scale production of fresh water from sea and brackish water.

(*To be continued*)

AMERICAN LETTER

New Applications for Old Techniques

ALTHOUGH many of the interesting processes and techniques so triumphantly announced are radically new developments, not a few are ingenious applications of older methods. Some may even have been standard practice for many years in different fields, thus supporting the arguments of the anti-specialists. Several recent American examples of considerable interest are described below.

The use of air in conjunction with a vibrating table can offer specific advantages, such as a dry product, low-cost operation and removal of super-fines or dust, in addition to partial classification according to shape, size or density, according to circumstances. Although not widely practised, this method has been used on materials such as granulated cork, grains and certain minerals. A recent further application, reported by the *U.S. Engineering and Mining Journal*, is the concentration of pyrrhotite ore at the Gossan Mine, Virginia, of the Allied Chemical Co.

In this application, the tables are used to produce a concentrate containing about 34% sulphur and a tailings of 8% sulphur from a feed averaging 25% S, sized in three ranges between $-\frac{1}{4}$ in. and 48 mesh. The feed moves across each table, which is covered with a porous deck of fabric or metal cloth through which an upward stream of filtered air is passed at a pressure of $\frac{1}{2}$-4 in. water gauge. No riffles are used on the tables, although in other instances, when dry tables have been used for classification, riffles have been found to give a sharper separation, particularly with materials of low density. The Gossan installation comprises three sets of three operating tables, plus one spare. The size of each table is said to be about 5 ft by 7 ft and the total plus 48 mesh material handled daily is approximately 850 tons. The simplicity of this type of classification would suggest greater application to processes remote from the mining industry. Another feature is the ease with which cuts can be made at any point on the discharge edge of the table merely by moving a baffle plate to the required position.

A Heat-less Drier for Compressed Gases

An ingenious drier for compressed air or gases has been developed by the Trinity Equipment Co. which requires no heat for regeneration and can give dewpoints below −200°F. The "Heat-les Drier", as it is called, comprises two absorbing vessels filled with the required molecular sieve or desiccant and the vessels are interconnected with automatic change-over valves and piping. In operation, wet compressed air or gas passes through one chamber and is dried. About 20% of the dried gas is expanded through an orifice to a lower pressure and passes through the second chamber, before being vented or used for secondary purposes. The remainder of the dry gas from the first chamber is used for the service desired.

The expanded volume of dry gas passing through the second vessel is regulated so as to exceed the initial volume of the wet gas. Under these conditions, the drying capacity of the identical second vessel will exceed that of the first. Consequently, when arranged for periodic alternate flow, one absorbing chamber can reactivate the other. Several advantages are claimed for this type of drier. In addition to the elimination of steam or electrical regeneration, and the risk of ruining the desiccant by accidental overheating, no increase of air or gas temperature after drying can be assured. Furthermore, oil and certain hydrocarbons can be reduced in the gas to a level of one or two parts per million simultaneously with moisture removal. Units are available up to capacities of 4000 scfm for working pressures between 60 and 6000 psig. The energy required for operation comes from the compression of the original gas.

A Water-oil Burner

From time to time, various claims have been made for prime movers and burners that could use water as a partial replacement for conventional fuels, but history has not substantiated these discoveries. However, a recent development in this field is the Utah Hydro Corp. burner.

This patented burner will operate on very low-grade viscous oil sludges and residuals having high carbon and free-water contents. Combustion is said to be so complete that smoke and fume are entirely absent. In operation, atomising steam at 80 to 130 psig is superheated in a stainless-steel coil inside the burner shell to about 1000°F, somewhat in blow-torch fashion. Steam requirements are between 1 and 4 lb. per gallon of fuel used and the burners are available in capacities ranging from about 20 to 300 gallons of fuel per hour.

Flame-Priming—a New Maintenance Tool

The descaling of moulds in the rubber industry by special gas torches was developed many years ago, and the Linde Co. recently announced the perfection of a similar method for priming metal surfaces prior to painting. Although intended for application to mining and milling equipment, the technique would seem to be particularly useful to the chemical industry for reducing overall maintenance costs and prolonging the life of equipment.

In the Linde method, a torch consisting of a number of closely-spaced jets burning a mixture of oxygen and acetylene at a high temperature and velocity is used to scrub the metal surface to be painted, thus loosening any scale and simultaneously driving off any moisture present. The removal of all free and combined water is of great importance, since a layer of moisture only one or two molecules in thickness can prevent a sound coating, as well as inducing corrosion underneath the paint film.

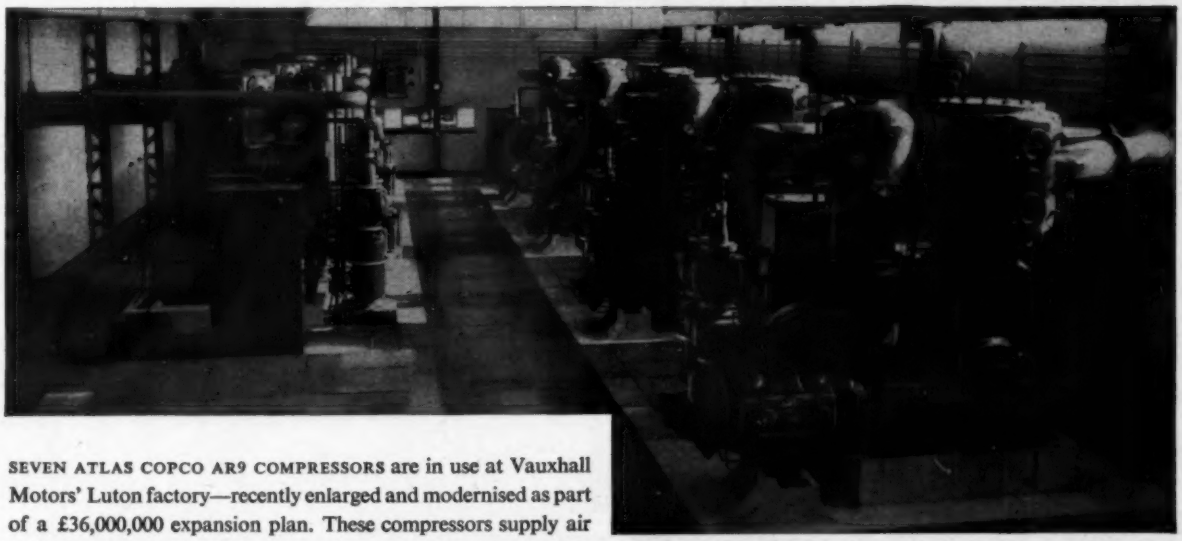
On flat metal surfaces not long from the mill, a torch speed of 50 fpm is possible, whereas heavily scaled or corrosive areas limit the travel speed to about 15 fpm. At an average speed of 35 fpm a 6-in. head will use about 13 cu. ft of oxygen and acetylene each and treat a little over 1000 sq. ft/hr. Under proper conditions, the distortion induced by flame priming is said to be negligible, and in most cases the metal temperature does not exceed 150°F. It is reported that, at some installations, annual painting has been replaced by periodic attention every three or four years as a result of flame priming.

A New Boost for Titanium

As is well known, advertising zeal outran technological discretion in some cases when titanium metal became commercially available some years ago. Despite premium prices compared to older corrosion-resistant metals, resistance to reducing solutions, hydrochloric and sulphuric acids was not of the highest order. However, the Union Carbide Metals Group have recently announced the discovery that as little as 0.1% of a noble metal, such as palladium, gold or platinum, under the right conditions will extend the application of titanium well into the reduction-resistant range, while maintaining excellent corrosion-resisting properties under oxidising conditions.

BCE 6340 for further information

Compressed Air at work in Vauxhall's Luton extension



SEVEN ATLAS COPCO AR9 COMPRESSORS are in use at Vauxhall Motors' Luton factory—recently enlarged and modernised as part of a £36,000,000 expansion plan. These compressors supply air to the body fabrication shops, press shops and other departments, providing power for clutch movements; resetting presses; mechanical handling; loading; welding; and mixing and spraying paint. In addition air is supplied for a number of pneumatic tools such as wrenches, grinders, drills and hoists.

ECONOMIC INSTALLATION

The AR9 compressors were installed at a cost below that estimated for other compressors of the same capacity. The reason being that the AR9 occupies 25% less floor space than is normally required —with consequent economies in compressor house costs.

HIGH OUTPUT

The Atlas Copco AR9 combines thorough reliability of performance with unusually high output per horsepower consumed. The installation at Vauxhall's has a total output of 22,540 c.f.m.

A COMPLETE RANGE OF COMPRESSED AIR EQUIPMENT

Atlas Copco manufactures portable and stationary compressors, rock-drilling equipment, loaders, pneumatic tools and paint-spraying equipment. Sold and serviced by companies or agents in ninety countries throughout the world.

Atlas Copco PUTS COMPRESSED AIR TO WORK FOR THE WORLD

Contact your local company or agent or write to Atlas Copco AB, Stockholm 1, Sweden or Atlas Copco (Great Britain) Limited, Maylands Avenue, Hemel Hempstead, Herts.

C.18

THERMAL CONDUCTIVITY OF GASEOUS NITRIC OXIDE

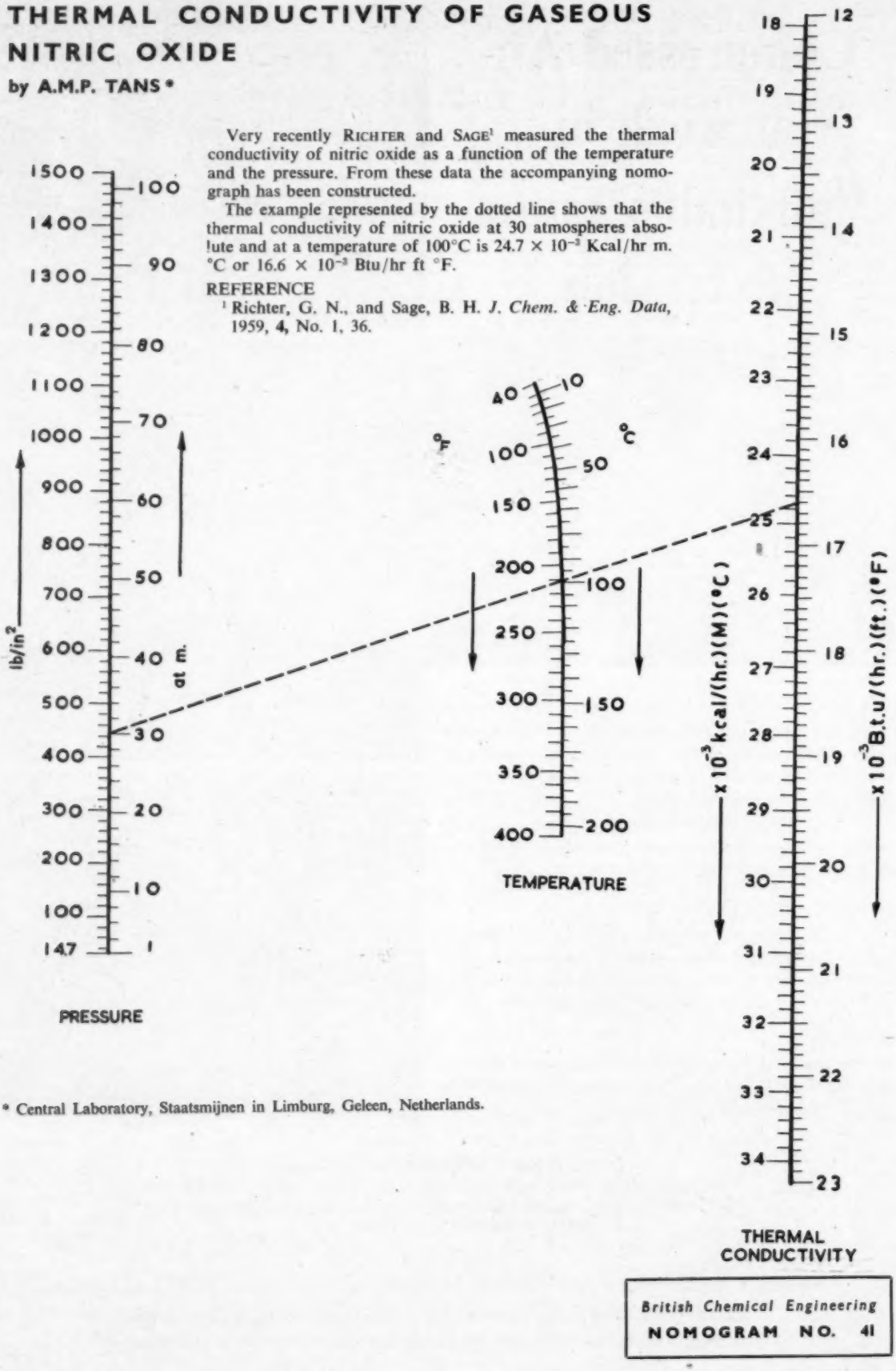
by A.M.P. TANS *

Very recently RICHTER and SAGE[1] measured the thermal conductivity of nitric oxide as a function of the temperature and the pressure. From these data the accompanying nomograph has been constructed.

The example represented by the dotted line shows that the thermal conductivity of nitric oxide at 30 atmospheres absolute and at a temperature of 100°C is 24.7 × 10^{-3} Kcal/hr m. °C or 16.6 × 10^{-2} Btu/hr ft °F.

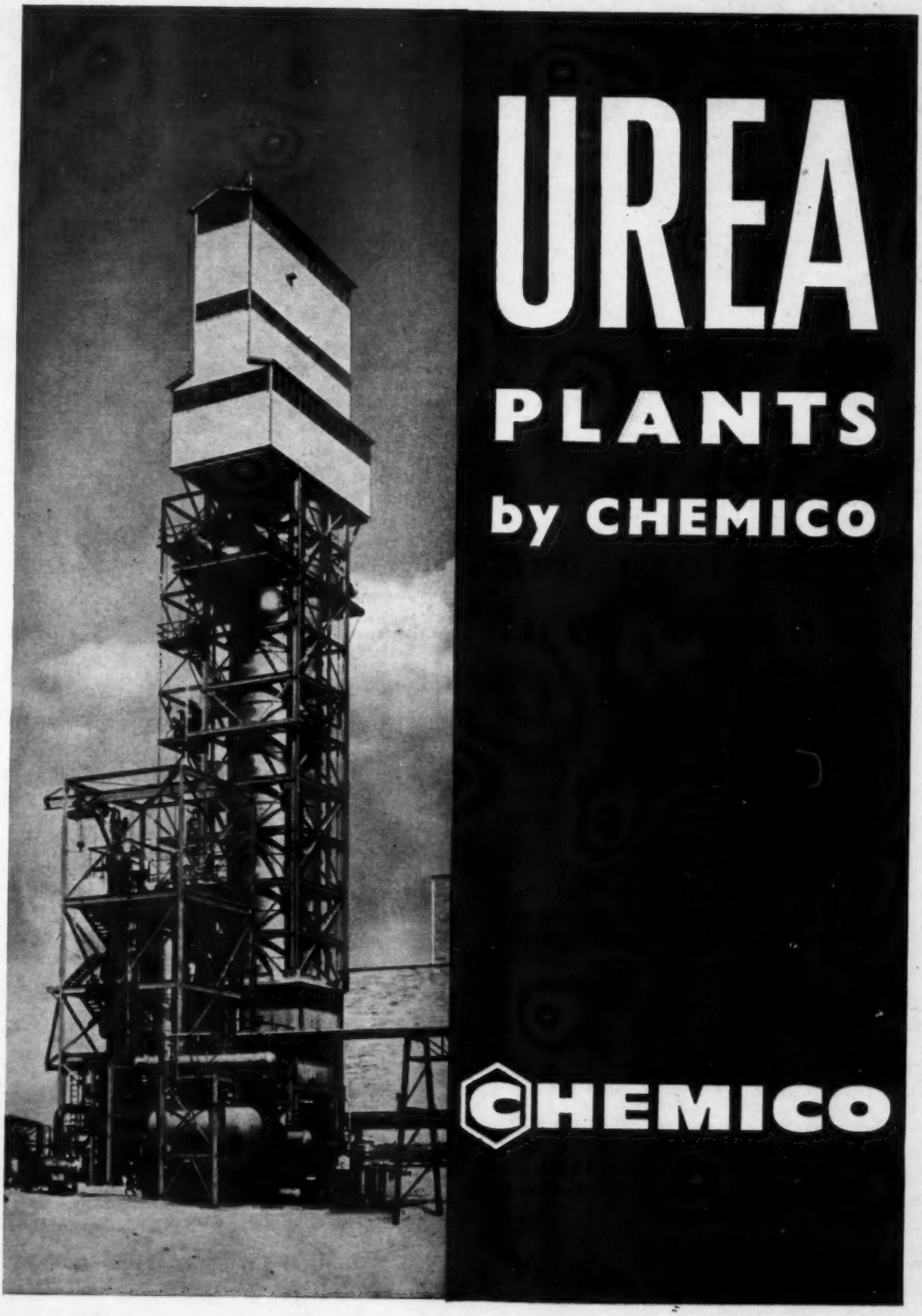
REFERENCE

[1] Richter, G. N., and Sage, B. H. *J. Chem. & Eng. Data*, 1959, **4**, No. 1, 36.



* Central Laboratory, Staatsmijnen in Limburg, Geleen, Netherlands.

British Chemical Engineering
NOMOGRAM NO. 41


UREA
PLANTS
by CHEMICO
CHEMICO

PROCESS ENGINEER'S NOTEBOOK

A Gas-failure Safety Device

A TEMPORARY STOPPAGE in the supply of the gas to furnace preheating equipment will extinguish the flame and, on resumption of flow, an explosive mixture will be formed in the hot furnace. It may also be necessary to prevent the pressure in the gas supply main falling below a certain minimum pressure to protect other appliances fed from it. The safety device described below will prevent these occurrences when installed in the supply piping.

The equipment is illustrated in the accompanying diagram and consists of two main items:

(1) a "U" bend fitted in the gas supply piping to the furnace preheating equipment; and

(2) a water storage vessel, positioned above the gas pipe.

Items (1) and (2) are connected by a ½-in. n.b. flexible seal pipe. The water in the storage vessel is maintained at a constant level by means of a drip feed and overflow pipe.

The design is based on the principle of the manometer. The head of water in the storage vessel is supported by the pressure in the gas main. On the failure of this pressure, the water flows into the "U" bend, where it forms a seal against further gas flow. The quantity of water required is related to the normal pressure of the gas supply and the bore of the "U" bend.

The method of operation is as follows:

(1) open valve No. 1 to ensure that the "U" bend is drained; close valve No. 1;

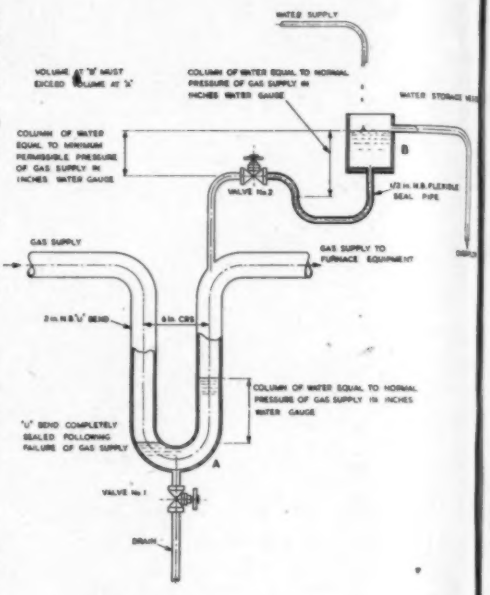
(2) close valve No. 2;

(3) fill the water storage vessel to the overflow level, leaving a drip feed from the water supply;

(4) turn on the gas supply and ignite the furnace preheating equipment; and

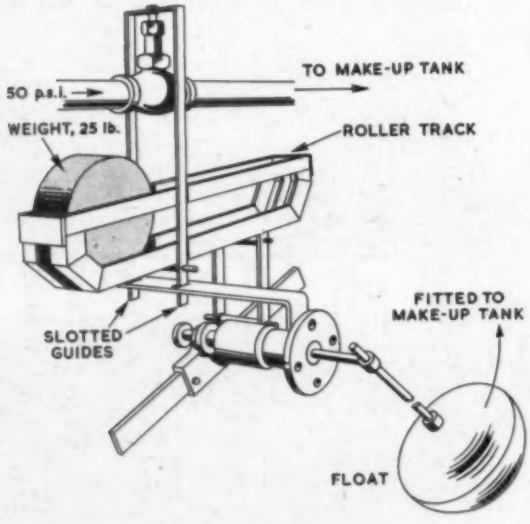
(5) open valve No. 2.

Following operation of the safety device after failure, and subsequent restoration of gas pressure, the gas supply to the installation should be isolated and the procedure above repeated to start up again. U.C.


WATER SUPPLY
COLUMN OF WATER EQUAL TO NORMAL PRESSURE OF GAS SUPPLY IN INCHES WATER GAUGE
COLUMN OF WATER EQUAL TO MINIMUM PERMISSIBLE PRESSURE OF GAS SUPPLY IN INCHES WATER GAUGE
VALVE No.2
GAS SUPPLY
GAS SUPPLY TO FURNACE EQUIPMENT
COLUMN OF WATER EQUAL TO NORMAL PRESSURE OF GAS SUPPLY IN INCHES WATER GAUGE
'U' BEND COMPLETELY SEALED FOLLOWING FAILURE OF GAS SUPPLY
VALVE No.1
DRAIN
A
B

Improvised Float-operated Valve

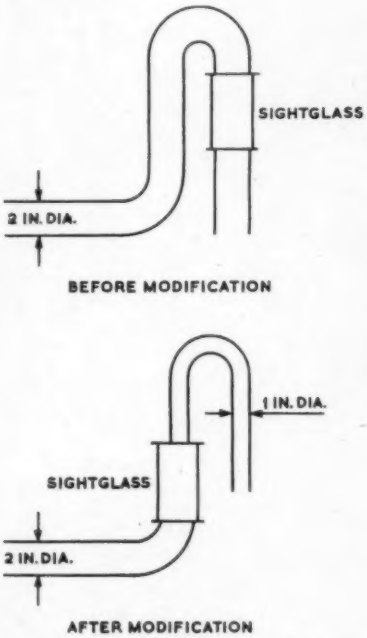
THIS IMPROVISED FLOAT control was devised to overcome the inaccuracy of a water meter caused through slipping at very low rates of flow. With the float valve originally fitted, when the water was near the upper limit of level in the tank, the rate of flow permitted by the valve was too low to be indicated by the meter. It was therefore decided to provide a float-controlled on-off supply of water to the tank, so that the water would pass through the meter intermittently and at a rate sufficient to be shown by the instrument. The float mechanism was modified to operate another valve fitted in the water feed line by means of a rolling weight device. When the water level rises in the tank the cradle carrying a cylindrical 25-lb. weight is tilted by the float. The weight then rolls over to the valve end of the cradle and causes the valve to close. The cradle is hinged and attached to a metal strip which operates the valve spindle to which it is bolted. A fall in level makes the weight roll over to the other end of the cradle, which lifts the valve spindle to its full extent and opens the valve.



Based upon an item described by E. G. GARDNER in *Power*, April, 1958, p. 132.

Modification of Sight Glass

THE COUNTER-CURRENT extraction of penicillin from aqueous to solvent phase is effected in a Podbielniak machine. At the end of this process it is necessary to displace the solvent from the machine by the use of water for the purposes of recovery. It was observed by a process chargehand that when this was done, some of the solvent remained trapped in the wide sight glasses employed on this machine, and that this material was lost to the process in the subsequent thorough clean out. This solvent became trapped because the flow through the sight glasses was not sufficiently rapid to sweep away the solvent which was lighter than water, the flow being downwards. The chargehand realised that if the sight glass arrangements were modified so that the flow was upwards the solvent would be floated away completely. The actual loss of solvent involved per batch was not large, but over the year amounted to an appreciable quantity. The attached diagram shows the arrangement of the pipework and sight glass before and after modification.



Sight glass before and after modification

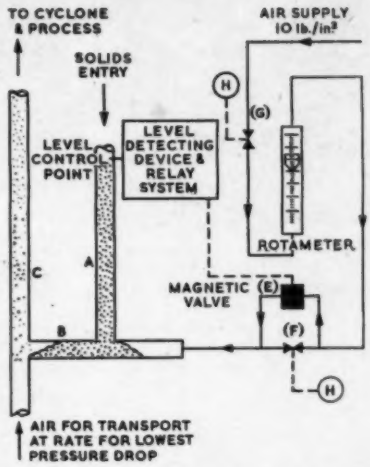
D. STOBBS

Process Chargehand at the Pharmaceutical Division of the I.C.I.

Controlled Feeding Device for Granular Materials

RECENTLY THE PROBLEM of feeding powdered solids at known rates into processes has become of great importance. The following system, which is similar to one described by HILL,[1] has been used with success in an experimental plant handling hot −30 B.S.S. mesh sand at known rates between 2000 and 3000 lb./hr. Sand from 2-in.-diameter standpipe A was passed to 2-in.-diameter transport pipe C via 2-in.-diameter connecting pipe B by means of a variable air bleed from a 10 psi source. The transport line, C, was supplied with air from another source at such a rate that minimum pressure drop for transport obtained. Control of feeding rate into the transport line was effected by maintaining a constant head in standpipe A. This was achieved by a level-detecting device and relay system (e.g., capacity change system) which opened or closed the magnetic valve, E, so allowing more or less feed air into B as the level in A rose above or fell below the control point respectively.

An initial calibration was necessary to set master feed air valve G to a balancing level and to throttle back the variation given by magnetic valve E by manipulating by-pass valve F. With rising temperature it was necessary to close progressively the master feed air valve, G, but at constant temperature the system controlled itself automatically against process variations such as momentary changes in pressure without the use of mechanical apparatus in the solid stream. In the experimental plant the system was used to balance the flow of solid from a calibrated orifice above the standpipe, but could be used equally well for variable-flow rates with suitable adjustment of the valves. As an example of operational details, a sand circulation rate of 2350 lb./hr was maintained with feed air rates of about 25 s.ft³/hr, with a magnetic valve differential of about 1-2 s.ft³/hr, transport air velocity (nominal) 33 ft/sec., and with a mean temperature in A, B and C of 350°C.



W. H. NEWTON

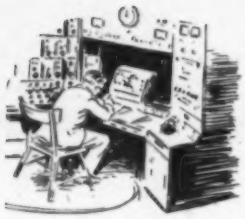
[1] Hill, H. W., *Chem. Eng.*, 1953, April, 374.

Thermoplastic Cloth Cutter

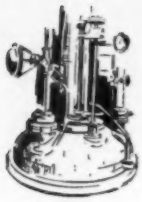
DURING THE PAST few years thermoplastic filter cloth has become widely used. This is due to its great mechanical strength and superior resistance to corrosive conditions. Cutting the cloths in the plant or pilot laboratory to fit the various sizes and shapes of filters, particularly filter presses, became a problem due to fraying of the cut edges. In general, this problem has been solved by hot cutting, using a roller knife heated in a gas flame which is then drawn along the cloth, melting it in two, the edges being sealed upon cooling. Filter press cloth holes were similarly cut using a heated arch punch or piece of metal tubing of the proper size. The obvious disadvantages of this method are the rapid cooling of the tools, requiring frequent reheating, and the unavailability of gas in many locations. To overcome these disadvantages, successful self-heating cutting tools were devised.

The basic hot cutter was made by simply hammering out the copper point of a heavy-duty electric soldering iron into a blunt knife edge. This electrically-heated cutter is then drawn along the edge of the filter cloth template, melting the cloth and automatically sealing the cut. A plywood backing board is used to protect the work surface. For cutting the holes in filter press cloths, another similar tool was fashioned. The point of another soldering iron was turned down to a size such that a force fit was obtained with the shank of a standard cork borer of the same size as the holes required in the cloth. Brass or other tubing could be similarly used. This tool will cut or melt holes in ten cloths simultaneously using a slight twisting motion, and, as a result of this, makes a clean, well-sealed hole with a minimum of labour.

F.L.C.



LETTERS TO THE EDITOR



Co-ordinators or Not?

Dear Sir:

The article by Davidmann in the July issue discusses the organisation of chemical plant projects and concludes that Project Engineers or Co-ordinators are not only unnecessary but are detrimental to efficiency. In the article he comments on two papers which were presented at the recent symposium on this subject.

The internal efficiency of a contracting organisation is not the only factor to be borne in mind, and the question of relationship with the client is of at least as much importance. Whilst the question of Project Engineers in relation to internal efficiency is a matter which may be debated on the lines of Davidmann's article, there is no doubt that on a large project such an appointment is essential from the client's point of view.

Generally speaking, there are two main groups of contractor and two main types of client. The contractors divide themselves into:

(a) the large organisations capable of handling individual projects worth up to several millions of pounds; and
(b) the small to medium-size firms who normally work in the range up to £250,000 or possibly £500,000.

The clients divide into:

(a) large firms with their own sizeable technical staff organisation which keeps a close liaison with contractors; and
(b) smaller firms who leave the contractor fairly well to his own devices.

Whichever combination is selected, the client requires to be kept fully informed of the state of the project throughout its life and monthly progress reports and meetings are normal procedure. From the client's point of view, it is a big advantage to keep to a minimum the number of contacts at the contractor's offices and this is where the Project Engineer becomes essential.

Davidmann cites the instance of a firm employing 30 co-ordinators at an annual cost of £45,000. This is certainly excessive and implies an organisation of considerable magnitude. I suspect that there are few true project engineers in the 30. Even so, the question of cost loses its significance when it is realised how much dearer it would be to make available a full team of specialists for each progress meeting, particularly as the majority of clients are located some distance away from the gathering place of contractors, London.

This is probably the most important reason for employing a Project Engineer, i.e., as an essential administrator. It is by no means certain that he cannot fulfil just as important a task on purely technical grounds. It must be remembered that the opportunities to gain experience of large projects have been very limited and men capable of this type of work are scarce. During any large project a thousand and one problems arise where the services of a good project engineer are invaluable.

Take as an example the co-ordination of the work of main sub-contractors. Those responsible for say (a) steam raising plant, (b) refrigeration systems, (c) cooling water services and (d) main and secondary pump houses are all going to offer different makes of starters and motors, heat exchangers constructed to various codes, different manufacturers' instruments for similar duties, a mixture of pneumatic and electrical control systems, etc., etc. It may be thought that these difficulties can be settled under Davidmann's recommended organisation by the issuing of contractor's or client's specifications and codes of practice by the specialist engineers. In practice, these points occur in such numbers and with such regularity that someone has to keep an eye on them. This means a Project Engineer.

A very important point, too, is that there is often a clash of requirements between specialist sections. A common practice is to give first bite of the cake to the mechanical engineering section and to leave the electrical and instrument engineers to fight for the remainder. A ruling is then required from someone. Again—the Project Engineer.

One other point arises from Davidmann's article, and this is a question of the professional standing of Project Engineers. I agree with him that it is desirable for a project engineer to understand the chemistry, etc., of a process, and it is therefore ideally a Chemical Engineer's job. The most important factor, however, is that he should be the most experienced man available, irrespective of profession, and as such he may well be a mechanical engineer. I have known projects where the most likely choice is an electrical or civil engineer, where the work is predominantly suited to them.

The relationship between the Chief Engineers and a Project Engineer need not be the difficult one that Davidmann envisages. In a large organisation each Chief Engineer concerns himself with laying down certain professional standards to which his engineers work and retains full authority on technical matters. Each seconds one of his engineers to the Project Engineer as a specialist adviser. With suitable men there is no difficulty in this method of working.

A summary of my main points is:

(a) that from the client's point of view a Project Engineer is essential;
(b) that from the Contractor's point of view a Project Engineer is not essential but is desirable;
(c) that a Project Engineer should be a highly experienced person; and
(d) that the profession of a Project Engineer is secondary to his all-round ability, but it may be desirable in specific cases to appoint a particular type of engineer.

I suspect that the papers of Owen and Turner and of Curwen were written from a client's point of view and depicted the ideal contractor's organisation they would like to see. The client's viewpoint is of the utmost importance in this respect.

Yours faithfully,
H. J. M. STEPHENSON

H. Bailey & Co. Ltd.,
Taylor Lane,
Denton,
Manchester.

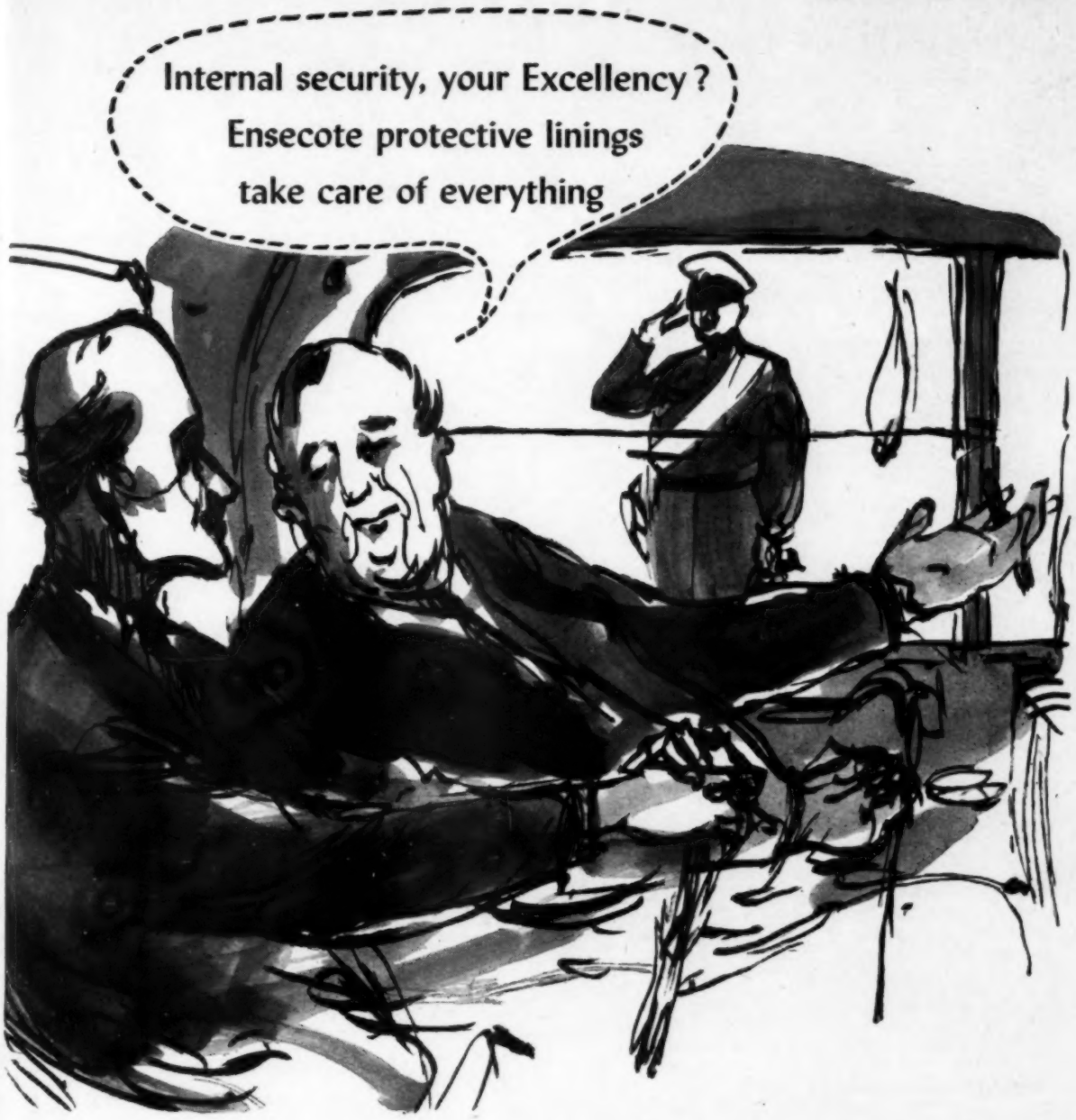
Mr. Davidmann's Reply

Dear Sir:

Mr Stephenson emphasises that the client's needs are of the utmost importance. Confining his comments to large projects, he considers that the contractor best serves his client by appointing a Co-ordinator rather than by improving his organisation. The Project Engineer's function is co-ordinating. Where Mr. Stephenson writes "Project Engineer", one may read "Co-ordinator".

One wonders why the client should be concerned in any way about the contractor appointing, or not appointing, a Co-ordinator. It is because of the contractor's internal difficulties in organisation that it appears essential to appoint a Co-ordinator and that it appears to be a big advantage to restrict the number of contacts to one.

If by "state of the project" is meant whether the original delivery promise is being maintained, then there is no need to use a team of specialists, or indeed a Co-ordinator, as the client can obtain the required information by telephone, letter or at a progress meeting, from an



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executive in the contractor's Planning Department.

Mr. Stephenson gives arguments which, when accepted, result in type "B" arising from type "A" activity. He demonstrates the sequence, given on page 405 of my article in the July issue, in the proper order. His arguments are listed below, with my comments in parenthesis, the reference numbers used here corresponding to those on page 405, point for point.

(2) A thousand and one problems arise. Mr. Stephenson then lists a number of these difficulties in organisation.

(These are difficulties arising from ill-defined or misunderstood functional relationships, from a division of work which is not, or is not seen to be, functional.)

(3) The Co-ordinator is an essential administrator. The services of a good Co-ordinator are invaluable. Someone has to keep an eye on them (the difficulties), namely the Co-ordinator. A ruling is required from someone who is, again, the Co-ordinator.

(The Co-ordinator is appointed, not because he contributes to the work the organisation is tackling, but because of internal defects in organisation.)

(4) The Co-ordinator has to be the most experienced man available, that is, a chemical, mechanical, electrical or civil engineer, dependent on the type of contract.

(The experienced Co-ordinator has experience of co-ordinating. He requires experience in a particular branch of engineering only if he has to make technical decisions. He cannot make such decisions without being responsible for the consequences. Mr. Stephenson is thus suggesting, indirectly, that the Co-ordinator be given at least some technical responsibility.)

(5) (A functional difficulty has to be resolved by a policy decision made by the executive responsible for both the work units concerned, as he is responsible for ensuring effective teamwork between them. Point (3) above suggests that such policy decisions be made, simultaneously and over the same field of activity, also by Co-ordinators. Considering point (4) above, here, also, responsibility would be divided, in this case between the the Chief Engineer concerned and a number of Co-ordinators. The organisation would lose efficiency.)

(6) Each Chief Engineer retains full authority on technical matters. Each seconds one of his engineers to the Co-ordinator as a specialist adviser.

(Many difficulties, in addition to those referred to in point (2) above, cannot be avoided. This system of activity is an extreme "B" type and suffers from all the disadvantages listed in the article.)

Consider point (6) above. An engineer is "seconded", that is, transferred, to a Co-ordinator who is thus responsible for his work on the project. The engineer is then responsible to his Chief and to a number of Co-ordinators, at the same time. If, on the other hand, the engineer acts as specialist adviser to the Co-ordinator, then he remains responsible to his own Chief for the quality of his prescription and thus cannot be transferred. Mr. Stephenson prefers engineers to act as specialist advisers on technical matters to the Co-ordinator, reserving for the Co-ordinator the authority to accept or reject the engineer's prescriptions. If the Co-ordinator makes such a decision, then he makes himself responsible for those aspects of the work which already are the responsibility of others.

The system of activity, described in point (6) above, makes heavy demands on the individuals to produce results. Where such a system appears to work satisfactorily, this is due to the quality of the individuals concerned, as pointed out by Mr. Stephenson, who seems to have extensive experience in this field. Even the simple line relationships are destroyed, as it is not appreciated that an executive superior must accept full responsibilty for the work carried out by his subordinates, and cannot be responsible for work done in another executive chain of responsibility and command.

It is seen that appointing a Co-ordinator creates many additional organisational problems, the organisation losing efficiency. Considering points (a) and (b) of Mr. Stephenson's summary of main points, one may then argue that the client's needs are best satisfied by the contractor overcoming his problems in organisation rather than by appointing a Co-ordinator. In his points (c) and (d), Mr. Stephenson considers that Co-ordinators should have experience. If this is technical experience, then it is of use only if they have to make technical decisions and as such technical decisions are already being made by executives in other departments, divided responsibility is inherent in the system he is advocating.

Yours faithfully,

M. DAVIDMANN
60 Drayton Gardens,
Winchmore Hill,
London, N.21.

Vibration Grinding—Front Cover

Dear Sir:

As the joint authors of the paper on Vibration Grinding in the symposium of papers on grinding, which was published in your issue of August/September, we would be most grateful if you would publish this letter to remove any misconceptions which might arise from the possible association of the cover photograph, the explanatory material on the contents page and our article.

We would like to emphasise that the choice of the cover photograph and explanatory material was entirely an editorial matter, and was made without our knowledge. It is also true that there are no statements connecting this material with our article, but we wish to ensure that no such connection is inferred. In fact, our researches have been carried out upon a specially designed and constructed research mill and we have conducted no tests whatever upon commercial machines.

We believe our findings to be fundamental, and therefore to be of general application, but it is for the reader to analyse the behaviour of other machines in the light of our results, and then to decide for himself the extent to which our findings are applicable.

We wish to make it clear that we have tested no commercial machines and are, therefore, unable to speak by inference or otherwise as to the performance of such machines.

Yours faithfully,

HORACE E. ROSE
R. M. E. SULLIVAN
University of London King's College,
Faculty of Engineering,
Strand,
London, W.C.2.

The cover picture of our August/September issue referred to above depicted a Podmore-Boulton Vibro-Energy Mill.

The Editor.

Viewpoints invited

THE EDITOR invites his readers to make use of these columns to air their views on matters of technical interest which have a bearing on subjects described in the journal's editorial columns. Letters should be addressed to the Editor (British Chemical Engineering, Drury House, Russell Street, Drury Lane, London, W.C.2) and should be, generally, of between 500 and 600 words in length. Rough diagrams and photographs will be accepted for publication should they be necessary to illustrate a point in question.

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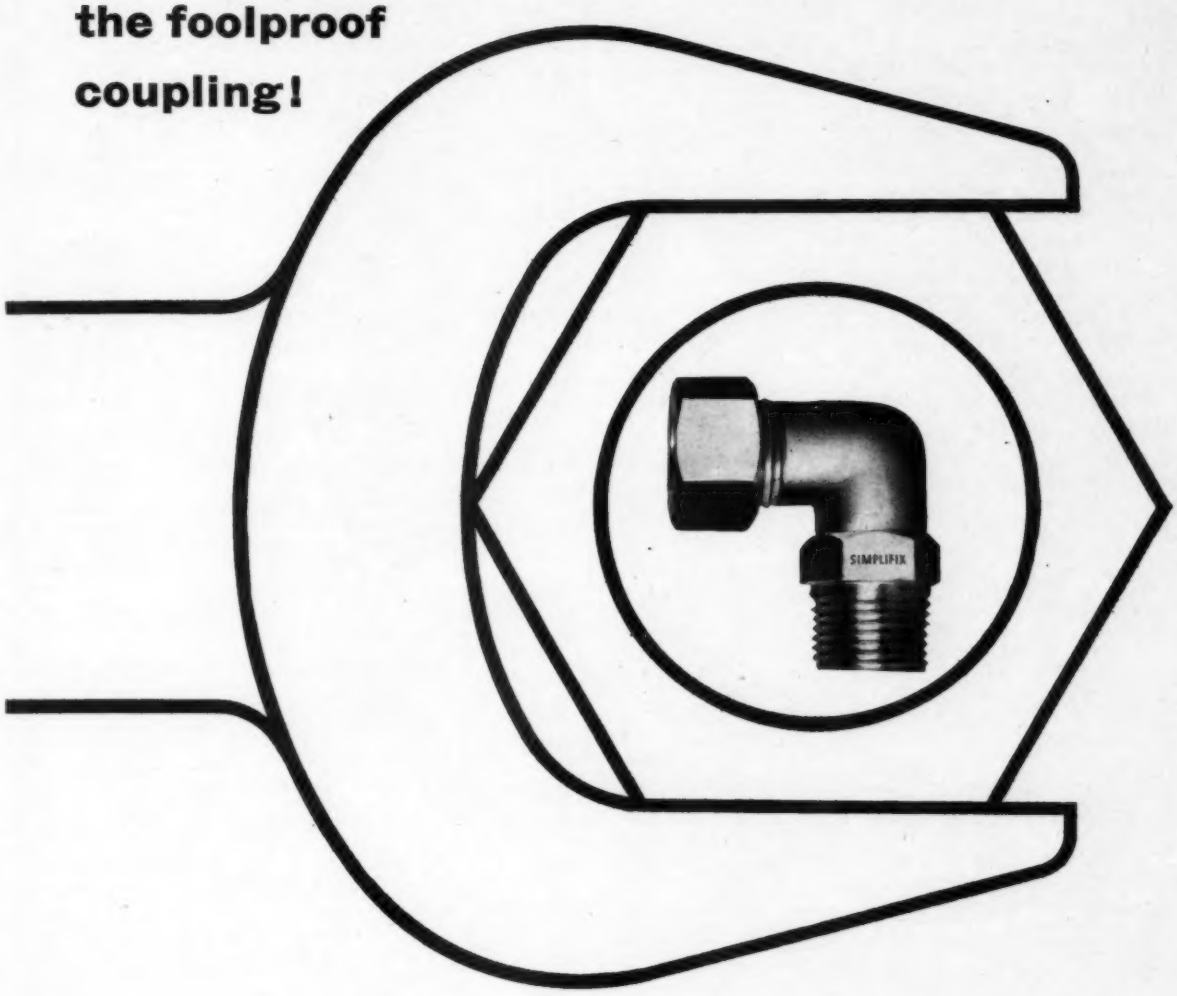

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Book Reviews

Thermodynamic and Transport Properties of Gases, Liquids and Solids

McGraw-Hill Book Co., New York and London 1959, 472 pp., 97s.

THIS volume comprises a collection of papers by German, Swiss, British as well as American authors presented at a symposium on thermodynamic properties sponsored by the Heat Transfer Division of the American Society of Mechanical Engineers.

The book provides a wealth of information on the thermal properties of liquids, solids and gases, and because of this should have a wide general appeal, despite the fact that some of the papers deal with highly specialised subjects such as the thermodynamics of boron compounds which have been studied in connection with U.S. Defence activities.

The value of the book, for those with an inquiring mind, is greatly enhanced by the fact that it opens with three excellent theoretical papers dealing with the thermal conductivity of metals, the emissivity of gases and gas transport phenomena. This is followed by a section reviewing recent work on transport properties and this contains a most comprehensive list of references which readers in many fields will find extremely useful. In the subsequent Sections III to IX a considerable amount of practical data is given, along with details of interesting new techniques being employed to extend our knowledge of the properties of matter. Important well-documented contributions on the thermal conductivity and viscosity of gases are given along wtih papers on PVT data and on the thermodynamic properties of gases, including studies at very high temperatures.

In a volume covering such a wide range of topics, it is hardly surprising to find one or two omissions. For instance, in the paper entitled "The Effect of Moderate Pressures on the Viscosity of Five Gases" the authors could usefully have referred to the work of Ross and Brown on helium, nitrogen and methane at 25°C, 0°C, −25°C and −50°C over the pressure range 70-700 atmas.

The book is clearly printed on good quality paper and should appeal to chemical engineers in many fields. The price of the volume will, unfortunately, prevent many readers from buying it, but its purchase by libraries will be fully justified.

T. J. WEBSTER

Scale-up in Practice

Edited by R. Fleming

Reinhold, New York, Chapman & Hall, London, 1958, 134 pp., 36s.

THIS little pocket-sized book contains seven lectures on different aspects of scale-up theory and practice, which were delivered to one of the numerous symposia of the A.I.Ch.E. The book is intended primarily for new-comers to the subject and it therefore sets out to review the field of scale-up in a practical way, to demonstrate the interconnection between its various aspects and to discuss some recent advances in scale-up technique. Finally, it seeks to draw attention to some commonly-encountered problems and offers some ideas for approaching them. The first chapter deals with the use of pilot plants for scale-up purposes and is concluded by the lively discussion which followed the reading of this paper. It brought to light the conclusion that, in large vapour-phase hydrogenators, plug-flow can be virtually assured, and maldistribution eliminated, by careful inlet and outlet distributor design.

Scale-up theory and its limitations are the subject-matter of the next section of the book and here the presentation is simple and easy to follow. The limitations discussed are based upon DAMKOHLER's conclusions and the residence time distribution work of DANCKWERTS, which latter has to be considered when chemical reactions occur in a system. The need for a greater knowledge of microscopic mixing is stressed, since this can often be the determining factor, even though macroscopic mixing may be similar.

Next to be dealt with is the use of analogue computers for scale-up purposes. Here the reader will be encouraged by the opinion expressed by the author of this paper (C. W. WORLEY), namely that any good engineer can master the use of the analogue within a short space of time. In fact, with the analogue technique all that is necessary is to translate problem equations into a series of connections between standard computer components. This is exemplified in the text, which provides thoughts on economics of computers and the accuracy of the answers they offer. An interesting sidelight, arising from the discussion, is the suggestion made by R. L. PIGFORD that the analogue, in addition to its application for solving design problems, for example, chemical reactors, could be used for simulating a process and for studying its control. Before this had been said, Laporte in this country had already completed such a study for their new hydrogen peroxide process.

How scale-up can mislead and what pitfalls can accompany its application are discussed in the following chapter. The difficulties outlined arose in the main from the petroleum refining and petrochemicals field and revolve around the presence of impurities and their accumulation. Of quite a different kind are the difficulties caused by poor communication of information, particularly at the point of transition from planned to actual operation.

The remaining chapters deal with economic factors of the kind which assist a business executive to decide whether to proceed with a project or not. This at first sight seems out of place in such a symposium, but closer reading justifies its inclusion, since its philosophy is basic and should be appreciated by all engineers. The final chapter is concerned with the problem of organising scale-up as a means of securing better results in innovation. Here a major part of the problem resides in the fact that organisations for scale-up are, by their nature, temporary.

This book can be considered to succeed in its purpose, although it has to be appreciated that it suffers from the limitations of being based upon a one-day symposium. Nevertheless, it is a useful introduction to the subject, and a book that can be recommended for refresher purposes before attempting to negotiate more advanced treatments of the subject. J.M.

Mathematical Aspects of Subsonic and Transonic Gas Dynamics

by Lipman Bers

John Wiley & Sons Inc., New York; Chapman & Hall Ltd., London, 1958, 164 pp., 62s.

PROFESSOR BERS' monograph reviews fluid flow from the mathematicians' angle. Mathematical models of physical behaviour are an essential part of predicting the behaviour of operating plant; for example, the motion of two droplets prior to collision has an important bearing on the design of gas scrubbing plant. Unfortunately, the average engineer will find Professor Bers' mathematical approach too difficult. The extensive bibliography could, however, help one to find a less advanced publication on a particular aspect. W. STRAUSS

Betriebstechnik—Verfahren und Operation

Volume 33 of the Dechema Monographs (Verlag Chemie G.m.b.H., Weineim/Bergstrasse, 317 pp., DM 37.50 or DM 30.00 to members of the DECHEMA).

THIS volume contains the text of 26 papers, some of which have been extended, presented at the European Congress of Chemical Engineering and the ACHEMA Congress, 1958, in Frankfurt am Main. The papers deal on the one hand with the course of chemical reactions and, on the other, with stages which precede and follow the main part of the process. The papers, which will be of interest to both chemists and engineers, deal with new methods for the production of hydrocyanic, acetic and phosphoric acids, synthesis gas, tantalum and niobium as well as specially purified manganese and silicon. An account is given of progress which has been made in plant design for carrying out the physical stages of processes, including distillation, evaporation, drying, filtration, centrifugation, atomisation, dust removal, heat exchange, the cooling of plastics compounds, new vacuum pumps, fluidised-bed processes and high-pressure electrolysis. Abstracts of the papers are given in English and French and a subject index is provided. This volume should prove of interest to works chemists and engineers.

The next volume to appear will be No. 34 of the Dechema Monographs and will represent the third and final work in the series "Betriebstechnik" and will contain a further 25 papers on the theme "Processes and Rationalisation".

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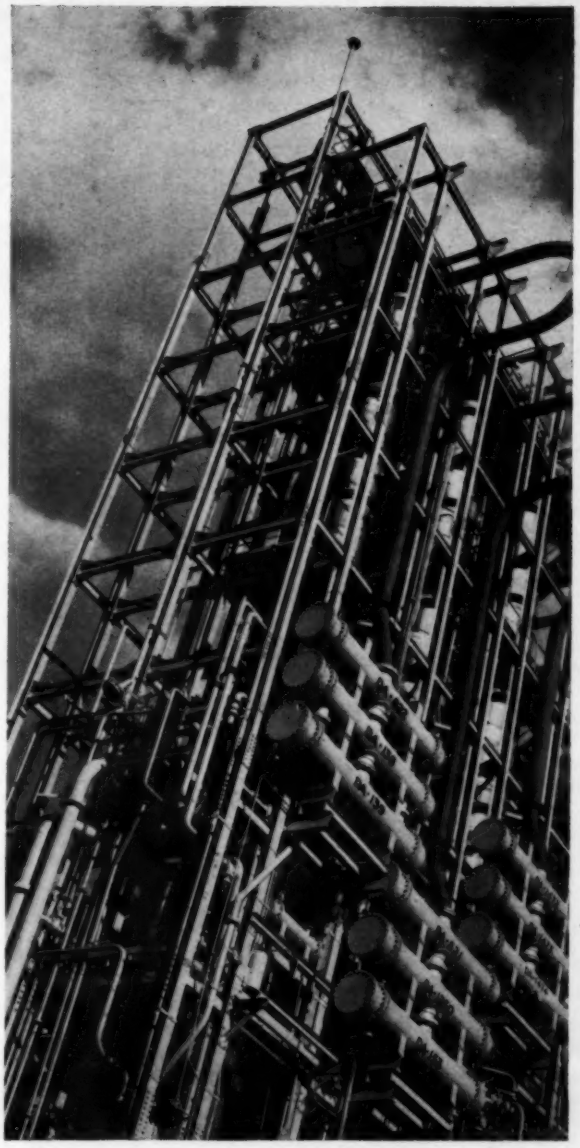

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World of Chemicals

New Refinery Projects

The Milford Haven Esso refinery—which is to include the largest pipestill of its kind in the world—is now half completed. Throughput is planned to be 4½ million tons a year, and the furnace of this pipestill will have a heat output of about 500 million Btu/hr. Fifty-six oil and gas combination burners are installed in two rows of 28 underneath the furnace. To avoid the problems of water cooling there are 14 Air Fin cooler units cooled by air supplied by four-bladed 10-ft-diameter propeller-type fans.

The plant is due to include six towers ranging up to 200 ft high and a Hydrofiner using a fixed-bed catalytic hydrogen treating process, using hydrogen from the powerformer to reduce the sulphur content of naphthas and diesel oils. This unit also employs air cooling. The light naphtha and turbo-jet fuels from the distillation unit will be treated in a copper chloride sweetening plant for the conversion of corrosive and unpleasant smelling compounds, in order to give a non-corrosive product with a pleasant odour. Apart from the boiler house, there is only one process control room for the whole refinery. All process operations will be controlled from this point by means of remote controls fitted to a graphic panel.

E.N.I., the Italian hydrocarbon corporation, plan to build a 100,000 million lire group of plants at Gela, Southern Sicily.

This will include an oil refinery, thermo-electric station and fertiliser and chemical factories. The project has already been submitted to the Government for approval.

An agreement between the Pakistan Government and a consortium of four British and U.S. oil companies has been signed for the setting up of an oil refinery near Karachi. The companies are Burmah Oil, Caltex, Shell and Standard Vacuum.

The refinery will initially be capable of refining 1.5 million tons of crude oil and will have the capacity to expand to 2 million tons.

It is hoped to complete the refinery within two and a half years.

Lincolnshire Chemical recently held an open day at their new benzole refinery at Scunthorpe, Lincs. This new refinery, replacing an old refinery on an adjacent site, incorporates an A.P.V. continuous distillation plant in conjunction with batch acid washing. It is designed for maximum production of pure products and has already proved capable of producing 425,000 gallons of nitration benzene per month, a figure in excess of designed capacity. In addition, quality of pure products has been most satisfactory and an indication of this can be gauged from the ease with which pure benzene of C.Pt. 5.4°C can be made (corresponding to 99.8% benzene w/w). Other products produced are solvent and nitration toluene, xylene, solvent naphtha, and indene coumarone fractions.

As previously announced, Lincolnshire Chemical in conjunction with the Steel Company of Wales are to set up the Port Talbot Chemical Co. Ltd. to treat the coke oven crude benzole available at Port Talbot. This new plant would be the first hydrorefining plant in the country to produce pure benzene.

U.O.P. Catalyst for Hydrogen Treating

Universal Oil Products Co. has announced a new catalyst, designated as Type S-4 Hydrobon, for use in Unifining and Hydrobon processes. This new nickel-containing catalyst is, say U.O.P., specifically designed to give superior results in the pretreatment of catalytic reforming feedstocks for contaminant removal, especially nitrogen and sulphur. It can also be used in the treatment of intermediate oils for improved colour, storage stability and sulphur reduction. The new catalyst is fully regenerable.

Type S-4 has several advantages as compared with similar types previously used, according to U.O.P. The new catalyst's activity in nitrogen removal is almost twice that of the earlier catalysts. Increased nitrogen removal from feedstocks gives definite improvements in catalytic reforming. Other advantages cited for the new catalyst include decreased catalyst requirement —resulting from lower catalyst density —greater heat stability and longer life.

Pfizer's New Development Department

To develop economic and convenient methods for manufacturing products, Pfizer Ltd. have now completed a new department near Sandwich, Kent, to link research and production. Known as the Production Development Department, it has the following four sections: Chemical Development Laboratory; Organic Synthesis Pilot Plant and Preparations Area; Fermentation Development Laboratory; and Biochemical Pilot Plant. The pilot plant and preparations area are well equipped with stirred tanks, centrifuges, filter press, pumps, exhaust system, tetra-aryl silicate heating system, steam ejector and other services. All arrangements are very flexible and can be used for carrying out the majority of chemical reactions on an intermediate scale. Many of the products prepared in this area are used for initial field and clinical trials and as raw materials for further investigational work. In the fermentation development laboratory, processes are developed in a similar way, but the semi-scale stage is at present carried out on equipment shared with production departments. It is hoped later to have available a fully independent pilot plant for large-scale fermentation investigations. A well-equipped biochemical pilot plant is already in use for studies of the recovery of valuable materials from experimental fermentation broths.

Polyethylene Capacity Doubled

S.p.A. Celene, the Sicilian polyethylene and ethylene oxide company owned jointly by Union Carbide and Societa Edison of Milan, Italy, has announced plans for doubling polyethylene production capacity. This expansion will result in an increase of facilities now under construction at Priolo, near Syracuse in Sicily. The completed installation will produce some 60 million lb of polyethylene annually. It is expected the original plant now under construction will come into operation during last quarter of 1959. It was also announced that Celene will expand its petrochemicals activities to include production of ethanol, butanol, 2-ethyl-hexanol and ethanolamines. This latest expansion represents the second addition to the company's Priolo plant.

Netherlands Urea Capacity

The Staatsmijnen, whose annual output of various fertilisers is already in the region of 900,000 tons a year, are to double their existing capacity for urea to give an annual output of 100,000 tons. This enterprise, which was the first in the Benelux countries to manufacture polyethylene (sold under the name of Stamylan), makes use of the high-pressure I.C.I. process and the Ziegler process. As yet, however, the manufacture by the latter process is being conducted on a pilot scale only.

Chemical Industry for Ghana?

Barclays Bank D.C.O. report from Accra that a team of three Japanese engineers has arrived to make a survey of the possibilities of commencing solar (natural evaporation) salt production in Ghana. It is understood that the survey may last four months and is intended to cover salt and related products such as caustic soda, hydrochloric acid, caustic potash, chloroform and bleaching powder. The setting up of a chemical industry in Ghana may depend on the findings of this survey, the Bank states.

Indian Chemical Projects

At the instance of the Indian Commerce and Industry Ministry, the Planning Commission set up a Drug Projects Location Committee in January this year to recommend suitable locations for the following projects: basic chemicals and intermediates; synthetic drugs; antibiotics; endocrines and glandular products; surgical instruments; and a photochemical project. The committee has now submitted its report to the Planning Commission and the report will be examined by the Government as soon as it is received from the Planning Commission.

BCE 6346 for further information

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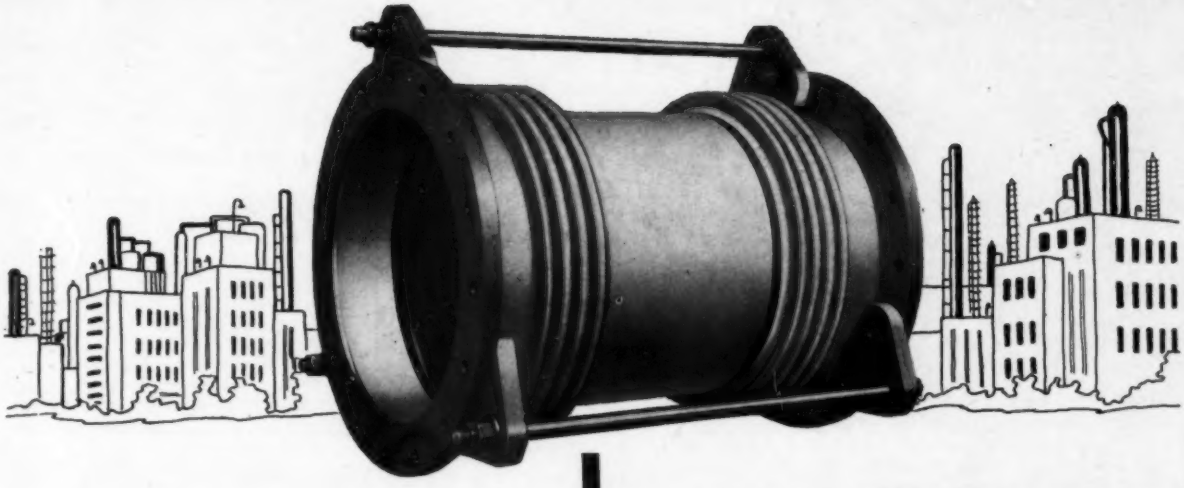

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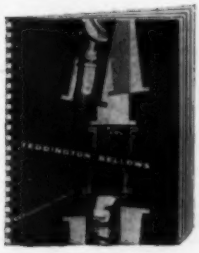

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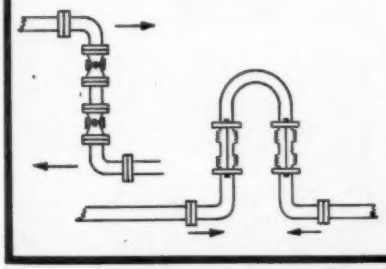

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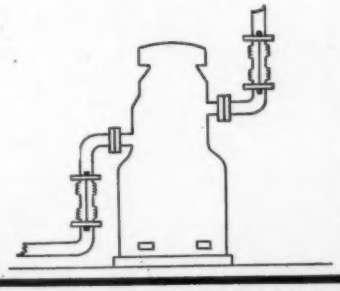

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Bellows units provide an absolutely leak-proof seal on valve stems.

TEDDINGTON

STAINLESS STEEL FLEXIBLE BELLOWS EXPANSION JOINTS

TEDDINGTON AIRCRAFT CONTROLS LTD (*Industrial Bellows Division*) Ammanford, Carmarthenshire. Tel: Ammanford 2255

PLANT EQUIPMENT NEWS

Thermostatic Soldering Irons

In the new Ceco thermostatic soldering iron (patents pending), the temperature is normally set to 250°C, but can be varied by the user if desired. There is an instrument model rated at 70 watts and also a larger industrial model in which the iron heats up in two minutes. The element is rated at 500 watts and the temperature—claimed to be accurate to ±15°C—is not affected by voltage variation. The manufacturers claim that the element in this iron will have a very long life. The bit does not alloy with solder at 250°C and needs only a rub with a cloth to clean it. In the thermostat is a micro-switch which gives negligible electrical interference, and the irons are insulation tested at 1000 volts. **Cardcross Engineering Co. Ltd., Woodyard Road, Dumbarton, Scotland.**

BCE 6406 for further information

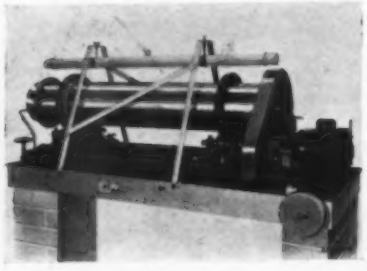
Thickness Measurer

The Elcotector is an instrument designed to carry out non-destructively a large number of measurements of coating or foil thickness. It operates on the eddy current principle in the on-tune position. The makers state that it has very great stability, and that one unit with one standard probe head can be used for a variety of tests. **East Lancashire Chemical Co. Ltd., Fairfield, Manchester.**

BCE 6407 for further information

Small-scale Crystalliser

A completely self-contained rotary drum crystalliser which includes all the essential features of typical full-scale units, and which has been provided with a number of useful design points in addition, has recently become available.



The drum of this unit is constructed of stainless steel and is 7½ ft in length and 1 ft in diameter. Saturated liquor is introduced by means of a feed pipe which enters at one open end of the drum, and the drum is cooled by distributing water over its surface. Mother liquor and crystals overflow continuously from the other lower end of the drum to a filter or centrifuge. A scraper chain of stainless steel, the tension of which can be varied over a wide range to satisfy individual crystallisation conditions, is also fitted, but, if desired, other types of scraper can be supplied. A high degree of flexibility has been incorporated in the design. It is possible, for example, to vary the drum speed from 1 to 2 rpm and alternative sprockets can be fitted which provide a maximum speed of 20 rpm and a minimum of 2 rpm. It is also possible to adjust the angle of inclination of the drum from 0 to 5 degrees. **The Kestner Evaporator & Engineering Co. Ltd., 5 Grosvenor Gardens, London, S.W.1.**

BCE 6408 for further information

Automatic Programming Equipment

A new type of programming and automatic control equipment is at present being demonstrated by English Electric in a van fitted out with a full-size unit controlling an ¼ scale working-model steel rolling mill. This type of unit can also be used with other industrial drives where a definite pattern of controlling movements is followed through in sequence and repeated many times; a different pattern of sequence merely requires the storage of a different programme. The heart of this programming equipment is a motorised switching device called a translator unit. At the moment it is being applied only to controlling mechanical devices and there is no feedback of information about the product. The field of applications envisaged is therefore for controlling known sequences of processing and production operations automatically. **English Electric Co. Ltd., Strand, London, W.C.2.**

BCE 6409 for further information

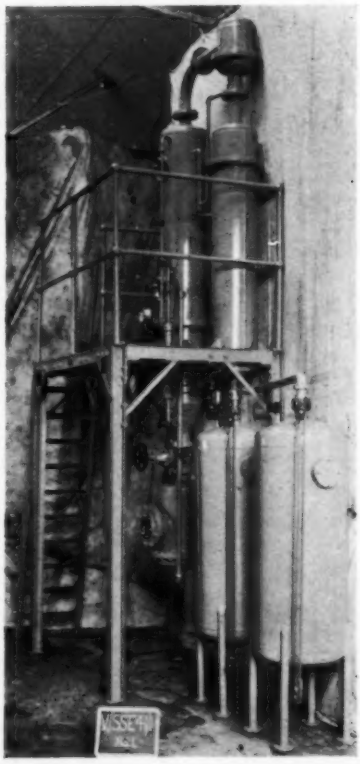
High-purity Oxide Refractories

Refractories capable of meeting the demands of modern technology require a high degree of purity in order that they may possess the requisite refractoriness and chemical compatibility. Purity indeed has been the prime consideration in the manufacture of the range of refractories announced recently by the Morgan Crucible Co. This range includes alumina, thoria, magnesia and lime-stabilised zirconia. The alumina is 99.7% Al_2O_3, and the components available in this material include tubes, bricks, tiles, die pressings and special shapes. For example, tubes up to 7 in. bore can be supplied. Thoria of composition 99.9% ThO_2 is obtainable, and in its impervious state is the most refractory of materials. Tubes and sheaths are among the articles which can be supplied in thoria. Components can also be supplied in the remaining members of this range of "Purox" materials. Tolerances of ±0.001 in. can be achieved readily, and both outside diameters up to 8 in. for lengths up to 3 ft can be ground, and bores up to 6 in. for lengths up to 1 ft. **Morgan Crucible Co., Battersea, S.W.11.**

BCE 6410 for further information

Pilot-plant Equipment

For the purposes of demonstrating chemical engineering processes, obtaining data to illustrate basic principles and for the design of full-scale equipment, Apex Construction have developed an extensive range of pilot-plant equipment. Typical of the units which can be supplied is the evaporator shown in the illustration. This is of the single-effect salting type and it is suitable for



determining rates of evaporation, overall heat balances and so on. It has an evaporative capacity in the range 14-20 gph, depending upon the type of evaporation. The equipment is constructed of mild steel and is suitable for vacuum.

Also available is a double-effect evaporator which can be used with backward, forward or parallel feed or as a single-effect evaporator with the first effect only in operation. **Apex Construction Ltd., 15 Soho Square, London, W.1.**

BCE 6411 for further information

We designed the micromerograph to solve our own particle problem...

. . . but it was too good to keep to ourselves

When you're dealing with separation problems every day it's essential to be able to measure accurately the size of very small particles.

All the existing methods had their snags. So we set about developing our own instrument. And over the years we developed the Micromerograph. It was so highly successful that we felt we ought to manufacture it and offer it to others who need a rapid, accurate, reproducible means of particle size analysis. It is now in use in a wide variety of industries.

The Micromerograph uses the air sedimentation technique which can be operated with solids in low concentration, due to the simultaneous development of a high precision null-deflection balance. The built-in deagglomerator applies a controlled and reproducible shear force to the powder sample so that particle aggregates can be broken down, whilst causing no destruction of individual particles. An automatic recorder gives a continuous statement of data.

The whole instrument is robust and automatically operated. Relatively unskilled personnel can use it. The Micromerograph has put into the hands of industry a means of production control and research which was previously unobtainable. Already many users have obtained dramatic improvements of product quality due to their use of the Micromerograph.

Another example of particle handling by Sharples is the new Sharples Super Classifier—a unique air vortex classifier that combines an ultra-sharp cutpoint with high capacity and unmatched efficiency. Write for Bulletin 1280 describing the Super Classifier.

Write for Bulletin No. 456M describing the Sharples Micromerograph or, if you wish, phone Camberley 2601 and talk to Martin Trowbridge about your problem.

Reading the Micromerograph chart—after the automatic recording of particle size distribution information.

SHARPLES

Sharples manufacture a complete range of Continuous Centrifuges, including—

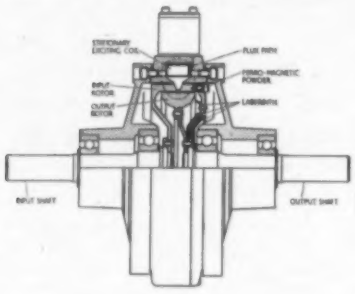
THE SUPER-CENTRIFUGE SERIES · THE DD-2 DISC BOWL SERIES · THE DH-2 NOZLJECTOR SERIES · THE DG-2 AUTOJECTOR SERIES · THE DV-2 VALVE NOZZLE CENTRIFUGE SERIES · THE SUPER-D-HYDRATOR CRYSTAL CENTRIFUGE SERIES · THE Q-18 SELF-DISCHARGING CRYSTAL DEWATERER SERIES · THE SUPER-D-CANTER SLUDGE DISCHARGE CENTRIFUGE SERIES · THE 1A LABORATORY CENTRIFUGE SERIES · THE SUPER CLASSIFIER SERIES · THE SHARPLES MICROMEROGRAPH.

SHARPLES CENTRIFUGES LTD., TOWER WORKS, DOMAN ROAD, CAMBERLEY, SURREY. *Telephone: Camberley 2601*

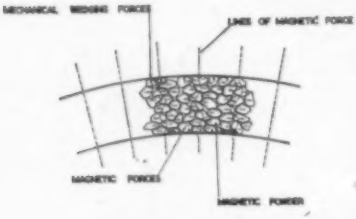
PLANT EQUIPMENT NEWS

Coupling for Power Transmission

A clutch which will operate without "judder", which sometimes occurs with normal friction clutches, and which will take up power with the smoothness of the best hydraulic devices are among the advantages possessed by a magnetic powder coupling now being produced by Smiths.



The main housing of this coupling carries the stationary field winding, concentric with which are the input and output rotors of the coupling. A small air gap separates the input rotor from the stationary field and the powder lies in the air gap between the input and output rotors. The main features of the coupling



are the absence of axial moving members for purposes of engagement, the fact that in the fully energised condition the input and output rotors become one solid mass; also, there are no driving pins or splines which are liable to wear, and slip rings and brush gear are not required. The net result is a coupling which is virtually trouble-free.

An important feature of the design is that the torque which can be transmitted is almost directly proportional to the exciting current in the electro-magnetic coil, which means that it permits remote control of the torque. The available models are in the torque range ½ to 200 lb./ft. **Smiths M. A. Ltd., 50 Oxgate Lane, London, N.W.2.**

BCE 6412 for further information

Liquid Metals for Corrosion Prevention

One of the disadvantages of methods of protection such as hot-dip galvanising, sherardising and flame spraying is the difficulty of applying them to equipment of massive dimensions. Painting is not a satisfactory solution, since the coating it provides is porous and the protection it confers is only temporary protection. A recently introduced surface treatment overcomes the shortcomings of ordinary paints by giving cathodic protection to the component treated. At the same time it is capable of resisting temperatures up to 1000°F. This new preparation, which is suitable for chemical works structural steelwork, is known as Metalife 1000 and has the further advantage of being non-toxic. **Metalife Ltd., Station Square, Harrogate.**

BCE 6413 for further information

Tanks in Glass-fibre Laminate

Tanks of capacity up to and exceeding 2500 gal. are now readily available to the chemical industry. These tanks are made by mechanised methods and require as little as 20-25 man-hours per tank. The fibres are pre-stressed and the method of construction ensures that the fibres themselves do not come into contact with the liquid contents of a tank. Normally a tank will withstand a pressure of 15 psi, and will tolerate steaming for sterilising purposes, which may be necessary when they are used for milk or food. With a suitable resin combination they can be used for many purposes in the chemical industry and can be designed for pressures up to 150 psi. **F. F. Jaray, Dr.Eng. (Vienna), 6 Sansome Place, Worcester.**

BCE 6414 for further information

Throw-away Air Filter

For applications where large quantities of air are used, such as paint finishing plant, chemical laboratories, distilleries and in ventilation, the Super-Vee panel based on a synthetic fibrous medium impregnated with adhesive is claimed to ensure high-filtration efficiency allied to long life. It is designed for the collection of sooty or tarry deposits without the danger of fibre migration. However, it will not deal with objectionable fumes or gases, usually present during "smog" conditions, which it is now believed are the main causes of bronchial disorders. The medium is unaffected by moisture, will not crack, and can be supplied in flame-resistant form. It has undergone tests based on B.S.S. 2831.

Using Test Dust No. 2 (Aloxite 50—mean particle size 5 microns) a 20 in. × 20 in. × 2 in. panel (1000 c.f.m.) showed a dust-holding capacity at 0.5 in. w.g. of 980 g. This is equivalent to a dust load of 400 g. per sq./ft of effective face area. Initially, a dust-retaining efficiency of 96% is achieved and this figure is maintained over much of the filter's service life. **Vokes Ltd., Guildford, Surrey.**

BCE 6415 for further information

Tar-epoxy Coating

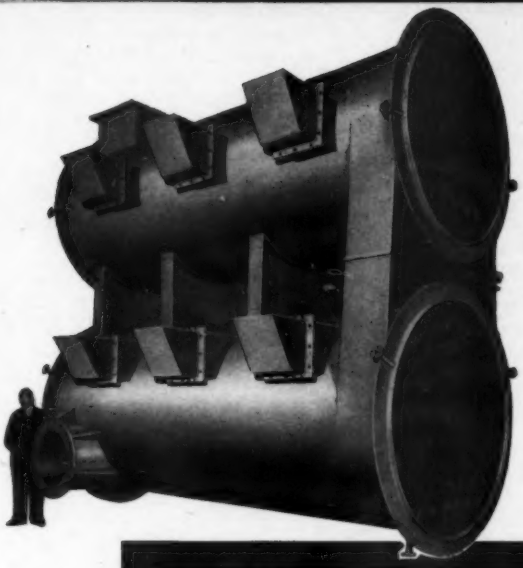
Corrosion Ltd. announce the introduction of EPI-TAR, a new coal tar-epoxy coating claimed to be of particular value to civil engineering contractors and others requiring a material with first-class protective properties and applicable under any weather conditions. Advantages claimed for EPI-TAR are as follows: a coating thickness of up to 10 thou. in a single brushed coat; a good resistance to acids and alkalis, to petrol and diesel fuels, to petroleum solvents generally and to oils, fats and greases; an excellent resistance to water, including salt water and hot water, and a wider tolerance with regard to surface preparation. EPI-TAR will, it is claimed, cure satisfactorily under almost any weather conditions, even if immersed in water almost immediately after application. It is a two-pack material and has a very long pot life (about five days) after mixing. It has a high rate of coverage (from 250 to 300 sq. ft per gal.) and is therefore a low-cost product in terms of both material and labour cost. It is claimed that there is no known hazard in any of the materials incorporated in it. The flash point of the solvents is at 85°F., well over the limit specified in the Petroleum Regulations. **Corrosion Ltd., Southampton, Hampshire.**

BCE 6416 for further information

Fittings in High-impact PVC

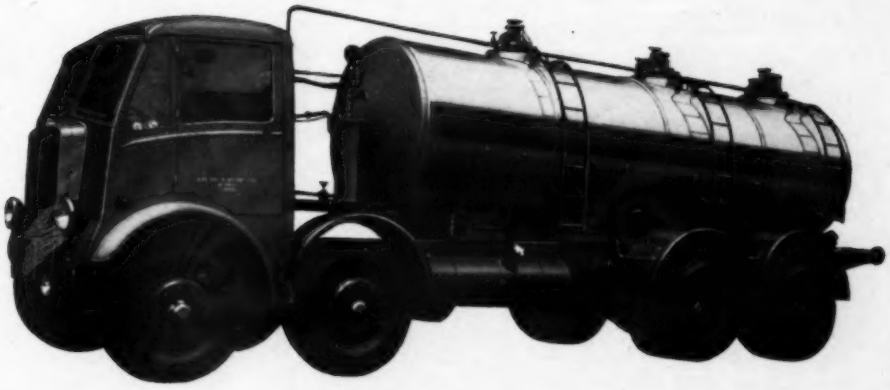
A new range of 6-in. i.d. fittings, injection moulded in Geon high-impact rigid PVC (Geon high impact PVC is made by British Geon Ltd., Devonshire House, Piccadilly, London, W.1.), has just been introduced by Durapipe & Fittings Ltd. Believed to be the largest mouldings of their kind in the world, the range includes T-pieces, elbow bends, sockets and flanges. The fittings shown in the photograph are of the 6-in. size, and have been designed for the oil industry for handling crude, effluent and corrosive liquids. The fittings are light in weight, shatterproof and made to the A.P.I. Schedule. **Durapipe & Fittings Ltd., West Drayton, Middlesex.**

BCE 6417 for further information



SPECIALISED FABRICATION

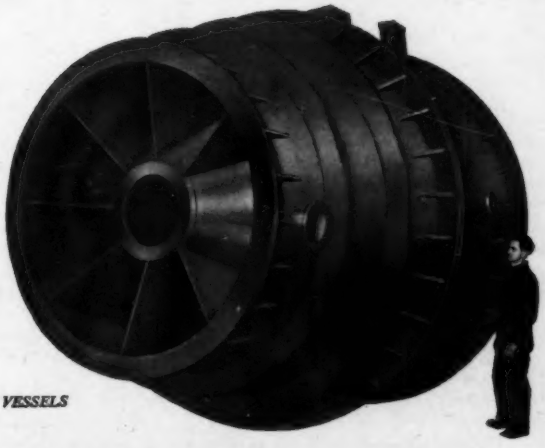
A large range of fabricated constructions is produced by Widnes Foundry & Engineering Co. Ltd. These three examples are typical of the skilful, comprehensive service offered to industry.



(*top*) Mild steel casing, consisting of two shells; overall dimensions: 17′ 6″ long, 9′ 3″ wide, 17′ 10″ high.

(*centre*) Aluminium jacketed stainless steel road tank, for transporting phosphoric acid.

(*right*) ¾″ Mild steel casing, weighing 4 tons, consisting of a cylinder and cone; dia. 9′ 7″ tapering to 6′ 2″ × 10′ 4½″ long.



WIDNES

FOUNDRY & ENGINEERING CO. LTD

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W 49

PLANT EQUIPMENT NEWS

Polarograph

An advanced single-unit pen recording potentiometric polarograph providing a high-speed permanent ink record in which direct or derivative polarograms can be obtained by operating a selector switch has been announced by Evershed & Vignoles. The Mark 19 incorporates facilities for variable damping and, in spite of its high sensitivity, the company state that its mode of operation is simple enough to permit its operation by semi-skilled staff. It is suitable for the analysis of metallurgical products, pharmaceutical

and industrial, organic or inorganic substances (plastics, for example). The sensitivity range of the instrument covers from 0.1μA to 150μA in 34 steps. The polarograph is operated from 200 to 260 volts or 100 to 120 volts A.C., 50 c/s mains. Sixty-cycle versions are available to special order. **Evershed & Vignoles Ltd., Acton Lane Works, Chiswick, London, W.4.**

BCE 6418 for further information

Pressure Transducer

Solartron have concluded with the Svenska Flymotor Aktiebolaget a manufacturing and marketing agreement of world-wide coverage (except Scandinavia) for a new "Vibrating Cylinder" pressure transducer which is claimed to be unique. The variable-frequency output signal makes it especially suitable for magnetic tape recording, particularly with the Solartron data recording equipment and for analogue-to-digital conversion by pulse counting. **The Solartron Electronic Group Ltd., Thames Ditton, Surrey.**

BCE 6419 for further information

Potentiometer Transmitter

Taylor Controls have started production on a new potentiometer transmitter which represents a unique concept in a bridge-balancing potentiometer. This instrument embodies an electronic circuit which eliminates the need for a slidewire, battery, standard cell or moving parts, and makes it possible to convert low-voltage measurement signals (millivolts) to an electric and/or pneumatic output with reliable accuracy and virtually maintenance-free operation.

It permits remote indication, recording and control from any primary element having a d.c. output or a suitable change in resistance. A continuous vernier range adjustment allows rapid and extremely accurate calibration of ranges from 3 mV to 50 mV. An identical continuous vernier range adjustment allows zeroing and suppression to be correspondingly simple. These two simplified adjustments are claimed to be unparalleled in the instrument industry. The same standard plug-in printed circuit amplifier is used on all Transet potentiometers regardless of the type of measurement. "Plug-in cans" permit instantaneous conversion of the potentiometer from one type of service to another quickly and easily.

The electrical output signal of the potentiometer amplifier (d.c. milliamps) to a pneumatic signal is converted by the transducer transmitter portion of the potentiometer transmitter. It is a force balance converter with a 3-15 psig output signal, which allows independent calibration with or without the potentiometer amplifier. **Taylor Controls Ltd., Hale End Road, London, E.17.**

BCE 6420 for further information

Heat Exchangers

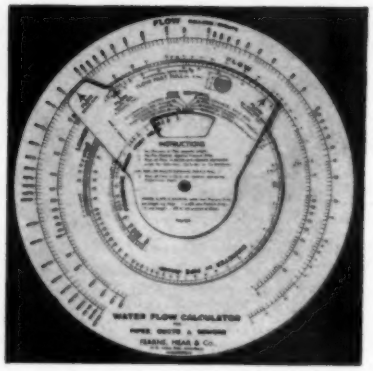
Details of various designs of plate heat exchangers, available in a variety of materials including titanium, are given in the latest A.P.V. publication A340. In addition to giving useful guidance on performance, this leaflet provides information on the wide field of application for these exchangers. **The A.P.V. Co. Ltd., Manor Royal, Crawley, Sussex.**

BCE 6421 for further information

Flow Calculators

In a calculator designed especially for water flow problems, the setting of two dials to the known details of a problem enables the answer to be read off in a few seconds. On one side this calculator solves the fundamental equation for the flow of water in pipes, ducts and sewers of circular section, running either full or partly full, and in any class of material such as steel, cast iron, concrete, brickwork, brass, etc. The scales have a wide range sufficient to cover all practical cases and the flow can be read off directly in cubic feet per second, gallons per minute or cubic metres per second as desired. The reverse side is designed to solve the Manning formula for the flow in open channels, scales being provided for area of channel, wetted perimeter, channel material and slope. The flow is read off directly in cubic feet per second or in gallons per minute as desired. The channel material scale, in addition to giving the flow for a wide variety of surfaces, is also calibrated in values of Kutters "n".

A gas flow calculator is produced by the same firm. The calculator is designed to solve the fundamental equation for the flow of gases through pipes under either high- or low-pressure conditions.



It does not, however, allow for deviations from the perfect gas laws at very high pressures. These are usually negligible at pressures below 1000 psi for most common gases although CO_2 deviates appreciably above 500 psi. **Fearns, Mear & Co., St. Helens Road, Almondbury, Huddersfield.**

BCE 6422 for further information

"Packaged" Cooling Tower

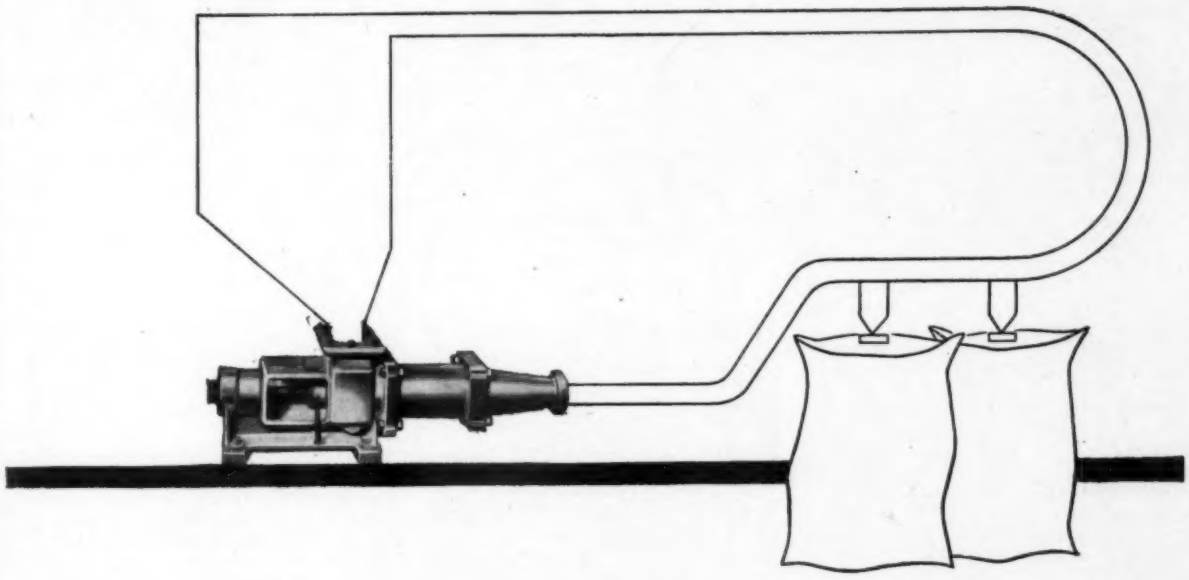
A packaged water tower with a resin-bonded glass fibre shell is now available in a size small enough to be transported in a light lorry and manhandled into position on site without the use of large cranes. Water is distributed by means of a main trough from which the water is discharged through Pyrex brand glass or nylon A.100.M orifice tubes into weir-type spreader troughs. The spreader troughs run the entire length or breadth of the tower at a pitch of 6 in. Each trough wall is staggered so that the water is discharged throughout the plan area of packing at 2-in. intervals. The timber film-flow serrated-grid packing is composed of a number of horizontal trays of parallel laths, the direction of the laths in each tray being at right angles to the trays immediately above and below it. This method of irrigation is claimed to ensure an entire and evenly wetted surface which results in the packing having an exceptionally high-heat-exchange coefficient.

The internal packing and distribution system is constructed of impregnated timber and is claimed to be proof against all known forms of wet, dry and soft rot organisms or termite attack. The tower is supplied ready for immediate operation, merely requiring the pipework to be coupled after the ground has been suitably levelled. Since the pond is an integral part of the tower, no foundation preparations are generally necessary. Capacities range from 300 to 5000 gallons of water per hour. **Film Cooling Towers Ltd., Lionel Road, Kew Bridge, Brentford, Middlesex.**

BCE 6423 for further information

BCE 6349 for further information

Have you thought of pumping powder for batching duties?



Ring main systems for pumping fluids to various stations are commonplace but have you thought of piping powder to controlled draw-off points?
Over many years the Powder Division of Mono Pumps Limited has obtained a mass of valuable information on the behaviour of piped powder and the Mono Powder Pumping System is a fully developed and compact system.
A service is available to offer advice on this subject whether it be for small or large systems.

✻ *Write for leaflet DM2 to give you an initial introduction to the System.*

MONO
Powder Pumping System

Powder Pumping Division
MONO PUMPS LIMITED · MONO HOUSE · SEKFORDE STREET · LONDON E.C.1
TELEPHONE: CLERKENWELL 8911 TELEGRAMS: MONOPUMPS 'PHONE LONDON

MP 304/L12602

PLANT EQUIPMENT NEWS

Hetron Resins

Albright & Wilson have announced that they are now able to supply Hetron resins, and the Het acid on which they are based, in Europe under an exclusive licence from the Hooker Chemical Corp., of Niagara Falls, America. A. & W. propose to allow British resin manufacturers to produce the Hetron resins and fabricators to make finished products under licence, while also supplying the resins themselves. Although more expensive than standard polyesters, they have, it is claimed, certain advantages which make them particularly attractive to fabricators. Non-inflammability and the ability to retain this property over a longer period of time than for standard resins is one such advantage, and, when used for electrical components, the electrical characteristics of the resins are not spoiled.

At the moment A. & W. can supply Hetron 92 (general-purpose flame-resistant polyester); 93 LS (a light stable resin with good weathering characteristics which are improved when a special lacquer (Hetrolac 105) is used with it); 32A (good impact strength and heat resistant); and Hetron 72, which offers the best resistance to chemical attack. This latter resin, it is claimed, has a high heat distortion point and excellent resistance to degradation at elevated temperatures. As it is self-extinguishing and cures at room temperature with a tack-free surface, this resin offers manufacturers of ductwork, tanks and exhaust hoods a product which has a high resistance to acid and acid fume attack. A. & W. state that other resins have been developed to meet specific customer requirements and details are available on request. **Albright & Wilson (Mfg.) Ltd., 1 Knightsbridge Green, London, S.W.1.**

BCE 6424 for further information

Wear-resistant, Anti-corrosive Finish

The Bostik "Endurion" process, demonstrated recently at the Factory Equipment Exhibition at Earls Court, adds a wear-resistant, anti-corrosive surface to the base phosphate coating of ferrous metals with good penetration into all the recesses of complicated shapes. A degree of lubricity is imparted to the surface which aids cold forming. Different colours can be given to the surface. Endurion provides an ideal undercoat if paint is desired. Minimum dimensional build-up occurs on accurate parts such as threads. Finally, the surface produced will remain serviceable 16 times as long as ordinary phosphate surfaces. The process produces no toxic fumes and, as no special equipment is required, it can easily be integrated into standard phosphate processes. **B.B. Chemical Co. Ltd., 34 Spring Lane, London, E.5.**

BCE 6425 for further information

High-impedance Voltmeter

The Guardion Corrosion Voltmeter, originally designed for application with cathodic protection projects, is now being offered for use in other fields. The manufacturers state that the range, compact design and extreme portability of this high-impedance voltmeter make it useful for a variety of other purposes where scientific accuracy is required in the field. Ancillaries such as miniaturised half-cell electrodes have been specially produced in conjunction with the instrument and it may fulfil a useful function as a measuring instrument for various transistor applications.

Ranges are 0 to 1 volt and 0 to 3 volts. Indicators are direct reading on 100 microamp. f.s.d. moving coil instruments with 5-in. mirror scale to B.S. 89. Accuracy, governed by meter calibration, is ±1%. The input impedance is 50 megohms, independent of range.

Forward and reverse reading facilities are provided, in addition to a built-in battery check circuit. **F. A. Hughes & Co. Ltd., Cathodic Protection Division, Mayfair Place, Piccadilly, London, W.1.**

BCE 6426 for further information

P.T.F.E. Products

Turner Bros. have introduced a range of P.T.F.E. fabrications which were shown for the first time at the recent Plastics Exhibition. The products, which are now generally available, are as follows: veneered tapes; gland packings (maximum outside diameter 20 in.); punched and machined solid gaskets, washers and discs; slit and milled envelope gaskets; machined components; expansion joints; plaited packings (P.T.F.E.; white asbestos/P.T.F.E., blue asbestos/P.T.F.E.). Some of the products manufactured by the company are shown in the accompanying illustration. **Turner Bros. Asbestos Co. Ltd., P.O. Box No. 40, Rochdale, Lancs.**

BCE 6427 for further information

New Publications

The Council of British Manufacturers of Petroleum Equipment announces that the 1959/60 edition of their composite catalogue of oilfield equipment manufactured in Britain is now available. There are 894 pages in the catalogue, 790 giving detailed technical descriptions of individual firms' products and services, with many illustrations and charts. The remaining 93 pages give details under some 2400 headings of the equipment manufactured by the 450 member firms of the Council of British Manufacturers of Petroleum Equipment. The price of the catalogue is £2 10s. 0d., and copies are available from the Council's offices at **2 Princes Row, Buckingham Palace Road, London, S.W.1.**

BCE 6428 for further information

Blessed with an approving foreword by the President of the Board of Trade, "British Instruments, Directory and Buyers' Guide, 1959", has been launched as one comprehensive volume of 600 pages replacing two earlier reference works. This is a complete and authoritative guide and handbook to all sources of supply of British instruments for science and industry, together with their components and accessories. It contains reference to all firms in the instrument and allied industry. Included are comprehensive classified lists of 2500 instruments and components, and a four-language glossary of headings is used in the index of products. Trade names are also given. **United Science Press Ltd., 9 Gough Square, London, E.C.4,** in association with **Scientific Instrument Manufacturers Association of Great Britain.** Price £2 2s.

BCE 6429 for further information

A new booklet from I.C.I. Metals Division entitled "I.C.I. Sheet and Strip —Copper and Copper Alloys" is stated to be the first comprehensive publication covering all I.C.I.'s main copper and brass sheet and strip production. **Imperial Chemical Industries Ltd., P.O. Box 216, Birmingham.**

BCE 6430 for further information

Ascog's latest list of spray nozzles for water curtains and surface flooding are contained in a six-page leaflet which also gives details of the advantages of the two systems in minimising or entirely avoiding the dangers of fire hazards. **Ascog Ltd., 44 Theobalds Road, London, W.C.1.**

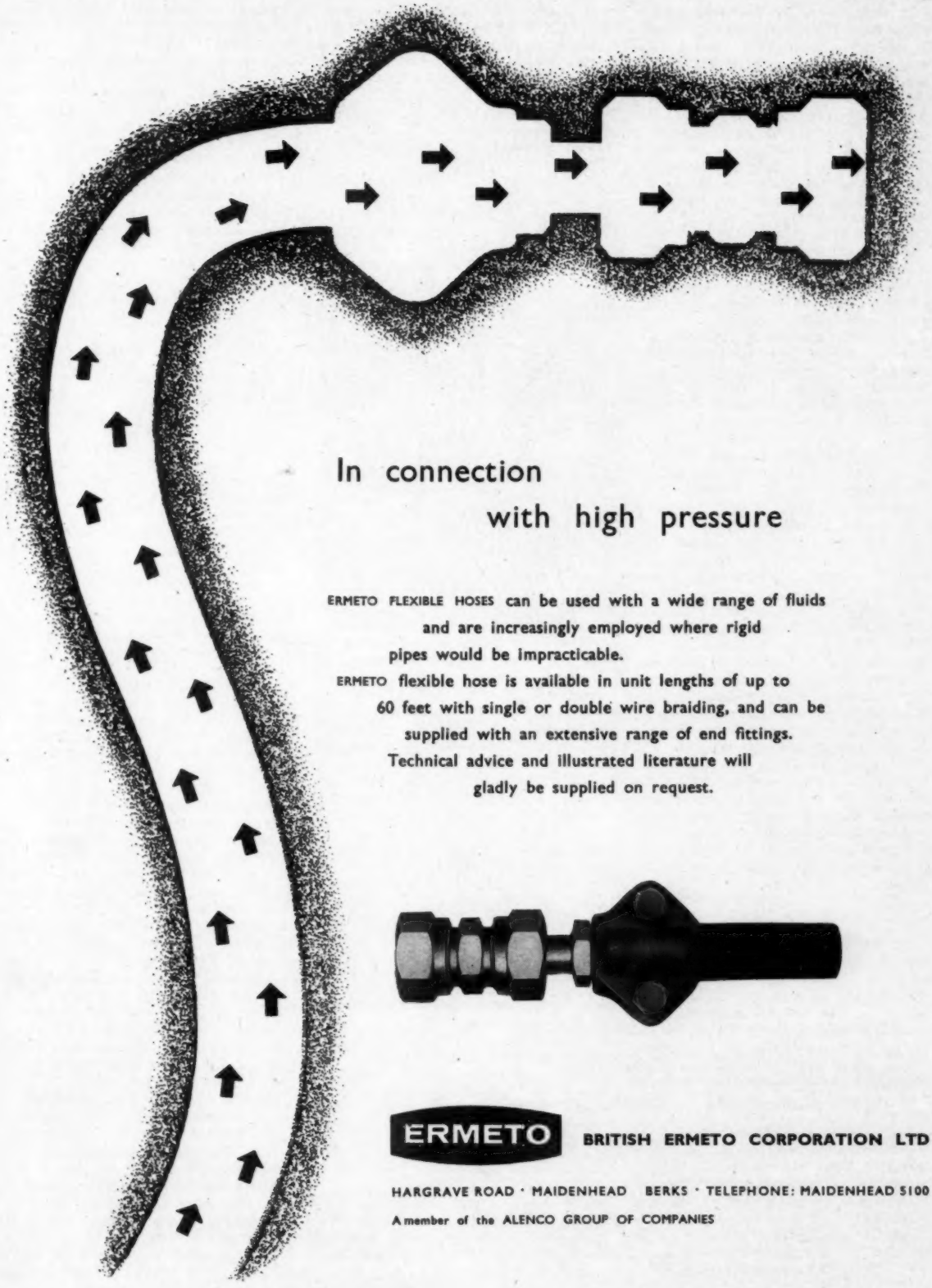
BCE 6431 for further information

A new data book describing their range of Geon P.V.C. materials and Hycar nitrile rubbers and latices has just been published by British Geon Ltd.

The data book provides basic technical information about the range of products manufactured by British Geon Ltd. It is divided into four sections, each dealing with a separate group of materials. These are Geon vinyl resins, Geon vinyl latices, Geon vinyl compounds and Hycar nitrile rubbers and latices.

Copies of the Data Book (No. 1) can be obtained from **Information Department, British Geon Ltd., Devonshire House, Piccadilly, London, W.1.**

BCE 6432 for further information



In connection with high pressure

ERMETO FLEXIBLE HOSES can be used with a wide range of fluids and are increasingly employed where rigid pipes would be impracticable.

ERMETO flexible hose is available in unit lengths of up to 60 feet with single or double wire braiding, and can be supplied with an extensive range of end fittings.

Technical advice and illustrated literature will gladly be supplied on request.

ERMETO **BRITISH ERMETO CORPORATION LTD**

HARGRAVE ROAD · MAIDENHEAD BERKS · TELEPHONE: MAIDENHEAD 5100

A member of the ALENCO GROUP OF COMPANIES

Month's News in Brief

New Company Formed—1

The Power-Gas Corporation Ltd. transferred its trading activities to two wholly-owned subsidiaries on October 1, 1959, which will operate from the same addresses in Stockton-on-Tees and London. Ashmore, Benson, Pease & Co. Ltd. will continue to control the Stockton works, while P. G. Engineering Ltd., a newly formed subsidiary within the Power-Gas Group, will undertake design, supply and erection of plant and equipment for the chemical, petroleum, petrochemical, gas, nuclear energy and other industries. The products and services of this company will follow upon similar lines to those previously available through its parent company—The Power-Gas Corporation Ltd. The reorganisation resulting from the expansion will, state the company, benefit their clients throughout the world by a greater concentration of attention upon their individual needs. None of the other members of the group is affected by this reorganisation.

New Company Formed—2

Mr. John I. Snyder, Jnr., chairman of U.S. Industries Inc. (Great Britain) Ltd., announced in London on October 1 that this new British company has purchased for cash the Burtonwood Engineering Co. Ltd., of Burtonwood, near Warrington, Lancashire. The formation of U.S. Industries Inc. (Great Britain) Ltd. to co-ordinate activities in Europe of the U.S. Industries Inc. (of which Mr. Snyder is president and chairman) was announced on Thursday, September 10. The Burtonwood Engineering Co. Ltd., which was founded in 1927, is mainly concerned with production of oil well equipment; precision machinery for the plastics industry; oil seals; and with engine reconditioning. Their main factory is at Burtonwood. In addition, the company have a factory in Welwyn Garden City; a small foundry and engineering workshop near Wigan; and a branch in Venezuela for the servicing of its deep oil well pumps in use in that country.

Contracts

Oy Vuoksenniska Ab of Finland has placed with Birlec Ltd. a £9000 order for an electric annealing furnace. Rated at 300 kW, the furnace is of the lift-off bell type, designed for annealing steel bars in lengths up to 6 metres. This is the third furnace of this type ordered by Oy Vuoksenniska Ab, whose plant already includes Birlec heat treatment and melting furnaces totalling over 5000 kVA.

John Thompson (Pipework) Co., of Wolverhampton, will supply the high-pressure pipework and valves for turbine sets numbers 5 and 6 at Blyth "B" Power Station. The company received the contract, valued at more than £490,000, to carry out this work. Commissioning of the first set is scheduled for Period 2, 1962. John Thompson-Kennicott Co., also of Wolverhampton, are to supply the water treatment make-up plant for the high-pressure boilers at Blyth. For these, 500,000 gallons of water a day will be required. The consulting engineers are Merz McLellan, of Newcastle upon Tyne.

The Head Wrightson Machine Co. Ltd., a subsidiary of Head Wrightson & Co. Ltd., has been awarded contracts for plant valued at £2½ million for the installation of an electrolytic tinning line at the Ebbw Vale works of Richard Thomas & Baldwins Ltd., capable of tinning and re-coiling 1500 ft of steel strip per minute. This line will operate at a greater speed and a larger output than any existing tinning line. Delivery will be made in 18 months and it is being designed in collaboration with the Aetna Standard Division of the Blaw Knox Co. of America, with whom The Head Wrightson Machine Co. Ltd. have been associated for several years.

William Boby & Co. Ltd., water treatment engineers of Rickmansworth, Herts, are supplying two complete demineralisation plants for Mexican power stations. One is for installation at a new power station in Oaxaca being built by Associated Electrical Industries Export Ltd. for the Comision Federal de Electricidad Juchitan. Boby's are also supplying acid dosing plant for condenser cooling water. The second similar set of equipment is for another of the Comision's stations, as yet unnamed.

Blaw Knox Chemical Engineering Co. Ltd. has been awarded a contract by Petrolite Ltd. for a synthetic chemical compounds plant. Erection work has commenced at the Petrolite Factory, Kirkby Industrial Estate, near Liverpool and the plant is scheduled for completion by the end of 1959.

The Clyde Alloy Steel Co. Ltd., a subsidiary of Colvilles Ltd., has placed a contract with the Kestner Evaporator & Engineering Co. Ltd., of London, for an acid pickling plant to treat 620 tons of steel billets and castings a week. The contract will also include a Kestner/Fakler acid recovery unit, a continuous neutraliser and fume extraction plant.

A contract to the value of approximately £2½ million has been awarded to Constructors John Brown Ltd. for the supply of a sugar factory at Kavar in Iran for the Sherkat Shami Ghande Pars Co. Associated with C.J.B. for the project is A. F. Craig & Co., of Paisley, who will supply the equipment which will be capable of processing 1000 tons of sugar beet a day, with allowance for eventual expansion to 1500 tons a day. Work will start immediately and the factory is due for completion by early 1961.

Changes

The London area sales offices of Northern Aluminium Co. Ltd. has moved from Bush House to new premises at 50 Eastbourne Terrace, London, W.2. Tel.: PADdington 3281.

Birlec Ltd., have established a Midland Area sales office with Mr. H. J. Podmore as manager. The new office will be situated at the company's main premises in Tyburne Road, Birmingham, 24.

Morehouse International, of Los Angeles, Guest Industrials Ltd., of London, and Durham Raw Materials Ltd., of London, Manchester, Glasgow and Birtley, Co. Durham, announce a change in the agency arrangements for the sale of Morehouse mills and Cowles dissolvers in the United Kingdom and Eire. Because of ever-widening commitments in other spheres, Guest Industrials are relinquishing the agency in favour of Durham Raw Materials, who will handle it through their expanding chemical engineering division.

News Briefs

Foxboro-Yoxall Ltd., manufacturers of industrial control instruments, have this year reached their 25th anniversary. A number of special events have been planned to mark this occasion and two of these, an Open Day and a Sports Day, were held with great success on September 4 and 5.

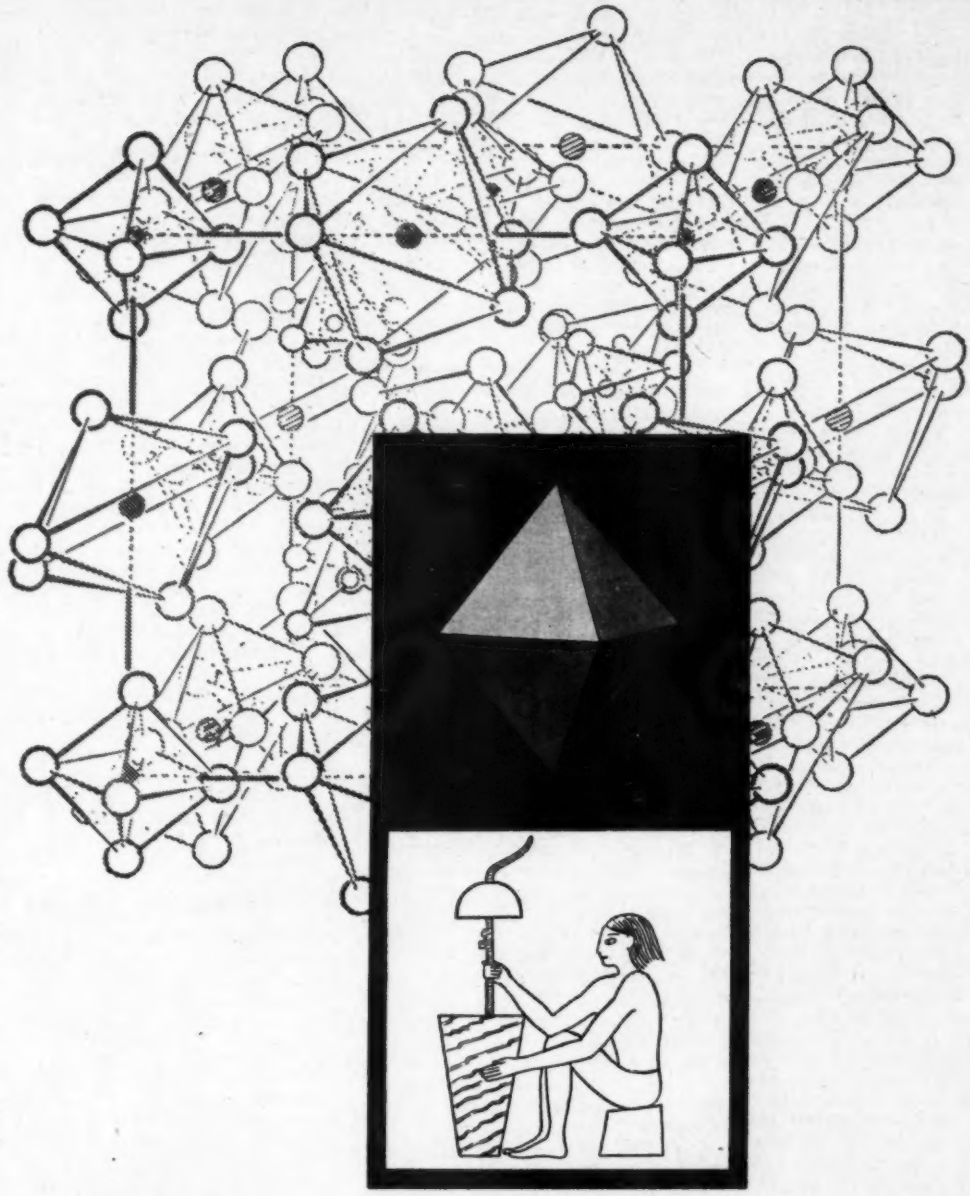
A new company, Coating Contractors Ltd., started operating in July at Buckingham. They apply a variety of high-build protective coatings. The new company is an associate company of E. & F. Richardson Ltd., of Buckingham, and their plant is situated adjacent to the factory of their parent company, who manufacture Adcora coatings. The new factory being built for Coating Contractors Ltd. will contain the latest equipment for surface preparation, application and handling. Preparation will most frequently be by blast cleaning.

Research work by the United Kingdom Atomic Energy Authority on the commercial-scale use of intense radiation for industrial purposes has now reached the stage at which a pilot plant is being built for operation by the end of this year. The plant is expected to be the first of its kind and size in the world and is being built at the Wantage Radiation Laboratories for the Technological Irradiation Group of the Isotope Research Division, Atomic Energy Research Establishment.

Clarke-Built Ltd. have been appointed exclusive distributors of products in the United Kingdom and the Republic of Ireland of the Cherry-Burrell Corporation of America, whose products include the Load-A-Matic load cell used for liquid level indication.

Neldco Processes Ltd. announce that they are now appointed sole agents for the Sterling Area for Krebs cyclones.

The Sandvik Steel Works Co. Ltd., Sweden, have decided to expand their existing laboratory facilities to meet the need for more intensified research and development work on their high-quality steel products. This is to be achieved by the construction, at an estimated cost of £265,000, of a new five-storey building



The earliest chemical industry

Naturally occurring alum has been used by mankind for over 4,000 years. The ancient Egyptians used alum for fixing dyes or mordanting, but this was only the first of many applications. Later it found use in medicines, in tanning, and in the treatment of parchment. Eventually it was realised that such treatment of parchment facilitated the application of ink and pigment, anticipating the present-day use of alum in the sizing of paper.

SPENCE

PETER SPENCE & SONS LTD., WIDNES, LANCS.
Also at London, Bristol and Glasgow.

(scheduled for completion in 1961) which will adjoin the company's main steel laboratory.

A new extension to the factory of Electropol Processing at the Farnham Trading Estate, Surrey, will treble its present capacity. This is the fourth extension since 1952. The new extension of 13,000 sq. ft, designed and constructed by Hewitts of Cranleigh, will considerably increase the facilities for the Electropol processing of stainless steels.

Nash & Thompson Ltd., England, announce that they are now the exclusive selling agents in the United Kingdom and Commonwealth for KOVO, the foreign trade corporation for the import and export of precision engineering products made in Czechoslovakia.

Kaiser Aluminium are to set up a private company in Great Britain to produce aluminium. Kaisers are the third largest producers of aluminium in America.

Elliott Automation Ltd. held a small exhibition of their products in the Connaught Rooms, London, during September, included in which was their magnetic core logical units developed by the company to meet the need for simple but reliable digital computing elements for use in industrial control applications.

"Industrial Electric Heating" is the title of the latest film to be added to the loan film library of the Electrical Development Association. The film deals with the theory, and at length with the practice, of electrical process heating of all kinds, for most industrial uses. Photographed in colour, the film may be obtained on loan from the Association at 2 Savoy Hill, London, W.C.2.

Pergamon Institute have published details on how interested parties may obtain results of research and development in the U.S.S.R. and other Soviet orbit countries in the scientific, technological and medicinal fields. Full details from the Executive Director, Pergamon Institute, Headington Hill Hall, Oxford.

Londex Ltd. held a private display at the St. Enoch Hotel, Glasgow, which coincided with the Third Scottish Industries Exhibition. Among the exhibits on show was their type HLS/SP Hopper Switch which is designed to control and indicate the level of free-flowing bulk materials. One new innovation with this type of switch is that it can now be supplied with hard-wearing, non-adhering P.T.F.E. diaphragms.

People in the News

Mr. J. E. Coleman has relinquished his directorship and major shareholdings in Spesco Developments Ltd., which will in future be controlled by Imperial Chemical Industries Ltd. Mr. Coleman has relinquished his interest in order to devote his full attention to the Gresham Lion Group in the field of automation, and automatic process controls in particular.

The following have been elected directors of B.H.D. Engineers Ltd.: **Mr. P. Rushworth**, director and secretary of W. C. Holmes & Co. Ltd.; **Mr. A. J. M. Henshaw**, director and general sales manager of W. C. Holmes & Co. Ltd.; and **Mr. P. Croset**, managing director of The Holset Engineering Co. Ltd.

Dr. A. G. J. Buckle has been appointed technical director of Technicon Instruments Co. Ltd. Dr. Buckle is at present in New York, and on his return will establish a full laboratory service in London for Technicon Instruments Co. Ltd.

The board of the Imperial Aluminium Co. Ltd., formed in June, has now been constituted as follows: From Imperial Chemical Industries Ltd.: **Dr. J. Taylor** (chairman), **Mr. B. Villiers** (managing director) and **Mr. M. Clapham**. From the Aluminium Co. of America: **Mr. DuBose Avery** and **Mr. F. J. Resch.**

Mr. C. Soukup, managing director of Richard Klinger Ltd., has retired owing to ill health. His retirement coincides with the birth of a new venture in Australia which he planned for the manufacture of Klingerit high-pressure jointing, and had ill health not intervened he would have been there to see the first sheets come off the calendars.

The board of Albright & Wilson Ltd. announce that **Sir Owen Wansbrough-Jones** has been appointed to a full-time directorship as from October 1. Sir Owen has held a number of senior scientific posts in the Civil Service, culminating in his appointment in 1953 to be Chief Scientist of the Ministry of Supply. Before joining the Army in 1940 and the public service in 1946, he was for several years Tutor of Trinity Hall, Cambridge, of which college he was a Scholar and is now Hon. Fellow.

Carbide Industries Ltd., a member of the British Oxygen Group of Companies, announce the appointment at their carbide and acetylene factory at Maydown, near Londonderry, of **Dr. T. W. T. Baillie** as production manager; **Mr. W. W. Ringland** as chief works engineer; **Mr. A. R. Robertson** as commercial manager; and **Dr. R. D. Thrower** as works research and development manager.

Dr. N. B. Dyson has been appointed to the newly-created position of manager, production planning and control, for Monsanto Chemicals Ltd. **Mr. G. V. Taylor** has been appointed works manager at Newport in place of Dr. Dyson. **Mr. K. H. Handy**, works manager at the new Monsanto factory at Fawley, near Southampton, has been appointed works manager at the Ruabon, Denbighshire, factory; and **Dr. E. W. Bodycote**, acting works manager at Ruabon, has been appointed works manager at Fawley.

The Board of Trade announce that **Mr. P. B. Inchbald** has been appointed a member of the Council of Industrial Design.

The President of the Board of Trade has appointed **Dr. F. Llewellyn Smith** and **Mr. I. W. Macdonald** to be part-time members of the National Research Development Corporation.

The Council of The British Gelatine and Glue Research Association announce the appointment of **Dr. D. A. Sutton** as Director of Research.

Mr. W. S. Bussey, chief of the Office of Weights and Measures of the National Bureau of Standards, has been elected a vice-president of the British Institute of Weights and Measures Administration. This is the first time an office of this organisation has been filled by someone outside the United Kingdom.

Meetings of the Month

Society of Chemical Industry

October 22. *At Manson House, 26 Portland Place, London, W.*1. "Polymers and Plasticisers Derived from Fats", by W. G. Ault. **7 p.m.**

October 29. *At Arthur D. Little Research Institute, Inveresk, Scotland.* "Stereospecific Polymerisation of Tactic Polymers", by Dr. M. Gordon. **7.30 p.m.**

October 30. *At Donnan Laboratories, University of Liverpool, Grove Street, Liverpool,* 7. "Bulk Handling and Storage of Heavy Chemicals", by W. A. S. White. **7.30 p.m.**

November 2. *At* 14 *Belgrave Square, London, S.W.*1. "Chemical Research in Germany", by Dr. Otto Hern. **6.30 p.m.**

November 5. *At Gas Showrooms, Shakespeare Street, Nottingham.* "Corrosion Factors Affecting the Choice of Stainless Steels for Chemical Plant", by H. T. Shirley. **7.30 p.m.**

November 10. *At Midland Institute, Paradise Street, Birmingham.* "The Manufacture of Synthetic Rubber in Britain", by K. G. Burridge. **6.30 p.m.**

November 13. Joint meeting with Royal Institute of Chemists. *At Denbighshire Technical College, Mold Road, Wrexham.* "Recent Developments in Chemical Plant Instrumentation", by R. M. Kerr. **7.30 p.m.**

November 13. *At the Technical College, Plymouth.* "Ion-exchange Membranes", by D. K. Hale. **5.30 p.m.**

Institution of Engineering Designers

November 9. *At Rutherford College of Technology, Northumberland Road, Newcastle upon Tyne,* 1. "Micro-switch Development and Design", by B. A. Holden. **7.15 p.m.**

Institution of Chemical Engineers

November 19. *At John Leggott's Grammar School, Cole Street, Scunthorpe.* "Fluidisation", by J. Trees. **7.30 p.m.**

Coming Events

October 26-30. *At the Main Electricity Board Showroom, Town Hall Extension, Manchester.* Morgan Crucible Company Exhibition, "High Temperatures in Industry by Electricity."

October 29-December 10. *At Bradford Institute of Technology, Bradford, Yorks.* Special evening course on "Design and Selection of Chemical Process Plant". Thursdays, **7.30 to 9.30 p.m.**

November 3-4. *At Royal Hotel, Scarborough.* Combustion Engineering Association Conference on "Automatic Coal-fired Boiler Plant".

November 5. *At Institute of Mechanical Engineers, Birdcage Walk, London, S.W.*1. British Occupational Hygiene Society 11th Conference, "Heating and Ventilation".